

# Light and Lighting

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One Shilling

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## Royal Lighting

THE great advantage of abundant light for exacting visual tasks, whether these be self-imposed in the pursuit of our "leisure" interests or necessitated by our vocations, is well exemplified by the practice of Her Majesty Queen Mary. On another page we reproduce a newly released photograph of Her Majesty engaged *outdoors* upon her now famous embroidery. Here she has the benefit of copious natural light and, on the arm of her chair, Her Majesty's "near-work" glasses lie closed and unneeded. Her comfortable viewing distance is in striking contrast with the fatiguing peering of people who attempt fine work in poor lighting. It is now well known that when working indoors upon the carpet she has presented to the nation Her Majesty, with characteristic wisdom, did so as close as possible to a window, so as to obtain "sufficient and suitable lighting." At night Her Majesty made use of an adjustable local light source to ensure reasonable illumination of her work.

Another notable feature of this issue is an article dealing with the artificial lighting of the residence of Their Royal Highnesses The Princess Elizabeth and the Duke of Edinburgh. The photographs we are able to publish show how tasteful, dignified and functionally suitable are the arrangements for lighting the different apartments.

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# Notes and News

## French Public Lighting Recommendations

It will be recalled that Mons. L. Gaymard, during his address last year to the I.E.S., mentioned that some recommendations for street lighting were about to be published in France, and that comments from this country would be welcomed.

These recommendations have now appeared in the form of a booklet published by the Ministère de la Reconstruction et de l'Urbanisme. Though published by the Ministry, the recommendations made in the booklet, which is the result of the work of a committee set up by the Association Française des Eclairagistes, are not intended as instructions, but only as guidance. (The introduction to the brochure contains the warning that no responsibility can be accepted for the cost of any installation based on the recommendations.) Wisely it is pointed out that in planning public lighting local conditions and resources must be taken into account.

With the continued shortage of power and materials in France it is probable that the standard of street lighting might frequently be somewhat less than that recommended; however, though low-power lamps may have to be used temporarily, it is recommended that cables and wiring be installed such as will support the full load when things are better.

The book, which runs into some 16,000 words, includes sections on the following: General lighting notes; Reflection characteristics of surfaces;

Light distributions; Height and spacing; Classification of roads; Lighting of subways; Focusing of reflectors; Characteristics of light sources; Fluorescent street lighting; Maintenance; Control; Supply; and Methods of mounting.

We hope to deal in more detail with specific recommendations in a future issue.

## New Lamps

Three new types of lamps were introduced by firms of the Electric Lamp Manufacturers Association on April 1. They include a new tungsten lamp, incorporating a new technique of diffusing bulb production which gives much greater diffusion than the pearl type lamp with only a slight increase in light absorption. The increased diffusion is obtained by an internal coating of minute particles of silica. Its diffusing prop-

erties make it very suitable for all situations where the lamp is wholly or partly exposed, and in many types of fittings it minimises the harshness of shadows on walls or ceiling compared even with those produced by pearl lamps. This lamp is at present available only in the 100-watt size.

Another introduction this month is a range of coloured fluorescent lamps in the 5-ft. 80-watt size. The four colours—red, yellow, green and blue—can be used to obtain a great variety of effects by combining the light from lamps of different colours in various proportions, with or without the addition of existing "white" lamp. The coloured lamps can be used in standard fittings and are available for ordinary or instant start circuits.

It is also announced that the recently

## I.E.S. Summer Meeting

The final notice for the I.E.S. summer meeting has now been circulated to all members of the Society. All who wish to attend the meeting at Buxton must, irrespective of any notice previously given, complete the form and return it to the I.E.S. secretary as soon as possible.

introduced "Mellow" lamp is now available in the 4-ft. 40-watt size. Mellow has already proved itself a popular and successful colour for a variety of commercial and domestic purposes, and the introduction of the shorter lamp makes it applicable in an increasing number of installations.

### Quantity and Quality

Though we don't want to give the impression that we are raising a hare and anxious to set the field amoving we are compelled to return to this subject this month owing to an unfortunate error in our previous comments. This mistake, for which we, fortunately and for a change, were not responsible, made complete nonsense of the last sentence of the penultimate paragraph which should have read: "It now looks as if we have reduced that nice phrase 'Quantity and Quality' to just the single word 'Suitability.'" The missing words were, however, fairly obvious from the text.

Though nothing to do with the subject and having just said that the above mistake was not our fault we might as well apologise at this point for the error on the same page in the date of the next I.E.S. meeting which should, of course, have been April 11.

### A Dictionary of Colours

Interior decoration and the lighting of building interiors go together—or should do—and the publication, by the British Colour Council, of a dictionary of colours for interior decorations is a welcome event. The new dictionary comprises three volumes, one of which contains an index with notes upon the colour names used, while the others contain samples of 378 different colours. Each colour is named and also identified by a reference number. The colour charts are in loose-leaf form and are arranged in two series, of which the first includes the more intense colours. In the case of most of the colours, examples are given on three different surfaces—glossy, matt, and textured (a pile fabric). Both the more intense colours exemplified in Volume I and the less intense colours in the series of Volume II are arranged in

the order of the spectrum. The dictionary is the work of Mr. Robert F. Wilson and Miss B. K. Battersby.

### Illumination and Industrial Ophthalmology

It is interesting to note that a Post-Graduate Course in Industrial Ophthalmology held in March, at the Birmingham and Midland Eye Hospital, included a lecture on "Illumination and its Effects Upon Industrial Production." This lecture, which was given by Mr. H. C. Weston, attracted a larger attendance than any other lecture in the course. The course was arranged by Dr. Dorothy Campbell, Director of Research at the hospital, who sought the assistance of the Birmingham Centre of the Illuminating Engineering Society to obtain a suitable lecturer.

### Exhibition News

We were interested to learn that the Council of Industrial Design are organising an exhibition of mid-century furniture which is to be held at the Tea Centre, 22, Regent-street, S.W.1, from April 26 to May 27.

The exhibits, all of which are already on the market, have been chosen from the 1951 Exhibition stocklist made up of goods submitted to the Council of Industrial Design by manufacturers as representing their best work.

The exhibition will give the public an opportunity of seeing a selection of modern furniture, together with examples of modern lighting, which, it is understood, will include standard lamps. It is to be hoped that, as far as the lighting is concerned, the designs will show more originality and imagination than did those seen at the recent Ideal Home Exhibition.

It is announced that a British Plastics Exhibition and Convention are to be held at Olympia, London, early in June 1951. It will be the first trade exhibition representing the whole industry and exhibitors will include those firms who supply equipment to the plastics industry. At the convention there will be lectures, discussions and films covering all aspects of materials, production and applications. Exact dates and further details are to be given later.



*A delightful study of Her Majesty Queen Mary taking advantage of natural daylight to embroider her now famous carpet.*

## A Royal Home

## CLARENCE HOUSE

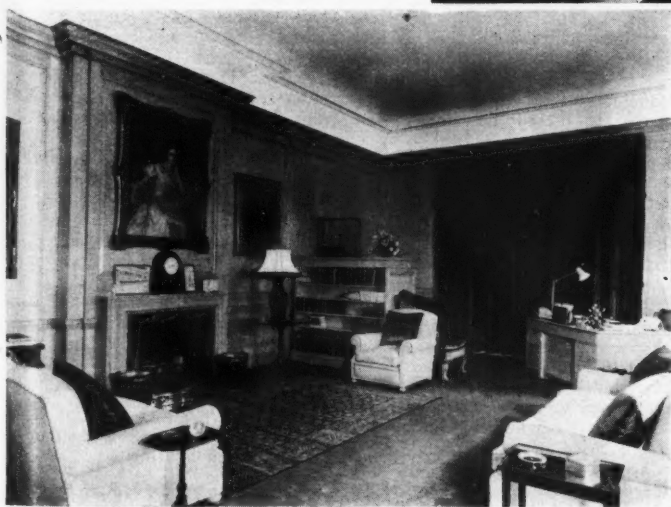
The following article on the home of Their Royal Highnesses, Princess Elizabeth, Duchess of Edinburgh and the Duke of Edinburgh, describes the interior decoration schemes with emphasis on the lighting.

Clarence House is essentially a home and the atmosphere is one of quiet, informal dignity. The interior decorations have been carried out according to the wishes of Their Royal Highnesses and, just as the interior arrangements of a home should, they reflect the personalities of the occupants. As will be seen from the illustrations, the rooms are large and well lighted, getting the sunlight from the south and west.

Before the announcement that it was to be the future home of Her Royal Highness The Princess Elizabeth and Lieutenant Philip Mountbatten, R.N., Clarence House



(Above). The front door.



(Left). H.R.H. The Duke of Edinburgh's sitting room.



was comparatively unknown, even to the Londoners who passed its doors every day. The house, designed by John Nash, was built in 1828 and, on his accession to the Throne, became the London residence of King William IV. It was enlarged in 1873 by the then Duke of Edinburgh and later became the residence of the Duke of Connaught.

Until the necessary alterations were made to fit the building for its present use, the internal appointments were exactly as they had been in 1873. During the last war, the house was used as offices and the roof was damaged by bombs. The task of renovation and modernisation was, therefore, no easy one; the electrical installation was extremely crude and arrangements had to be made for complete re-wiring.

As already stated, Clarence House is first and foremost a home; it is not to be expected, therefore, that there is anything spectacular in the way of lighting. The lighting is, however, both decorative and efficient; the principles and ideas applied are quite simple and equally applicable to most other homes. The following description is based on the lighting, but information is also given on the general schemes of interior decoration.

The principal rooms lie on the west side

of the house. Entering from the portico on the south side, one comes into a long corridor off which are the Duke's sitting room, the library and the dining room. There is a staircase at the north end of the corridor which leads to the drawing room and to Princess Elizabeth's sitting room. On the floor above are Prince Charles's day and night nurseries. Their Royal Highnesses' private suites are in a separate wing.

The front door in the outer hall is flanked by a pair of pedestal lamps and the gallery inside is painted pale cream, the close fitting carpet being a mushroom grey. This gallery is lit by four chandeliers, the sparkle from which shows up the mahogany furniture to great advantage against the light walls.

The Duke's sitting room is lined with panelling made in Canada of Canadian maple and has deep green curtains and carpet, the settees and easy chairs being in natural leather. His Royal Highness's desk is situated in the corner made by the south and west walls so as to derive the maximum

(Above). The library, showing the continuous cornice lighting.

(Right). The dining room and H.R.H. Princess Elizabeth's sitting room.





(Above). The drawing room.

advantage from the large windows in each wall. Apart from local lighting on His Royal Highness's desk and at the bookshelves, this room is lighted entirely by cornice lighting similar to that in the library.

The library is an extremely tasteful room; a library in which it would be a pleasure to read and a room in which one is not shut off from the light by projecting shelves, but where full use is made of natural lighting and where the artificial lighting is arranged to give good illumination on the bookshelves with complete absence of glare. The colour scheme is off-white with a magnificent Indian carpet with a ground of deep blue. Continuous cornice lighting of architectural strip lamps in 18-inch units is installed. Over the fireplace the cornice has been pierced to give downward lighting, without any additional or supplementary light sources, on to the painting of H.M.S. Vanguard. There is also a central lighting fitting with a large alabaster bowl.

From the library, one can pass straight through into the dining room where the wall decoration is picked out in off-white on pale apple-green. Here, wall brackets of Regency design form the main lighting. Local lighting points are provided by the sideboard, side

tables and carving tables, and there is a central floor plug beneath the dining table for the illumination of table decorations.

The Princess's sitting room on the first floor is again particularly well served with natural light by windows on two sides of the room. Here again, the general scheme of light colours is continued; the walls are a delicate shade of aquamarine blue, specially selected by her Royal Highness, and the Chinese carpet is of natural wool. The main lighting, as will be seen from the photograph, is from a Waterford glass chandelier which glitters most effectively upon the mahogany furniture, emphasising its rich tone. Supplementary lighting is again provided by wall brackets and table lamps.

The drawing room, made from a combination of two of Nash's earlier rooms, is lighted by means of two lovely chandeliers, with wall brackets and standard lamps for supplementary and local lighting.

It will be noted from this very brief account that throughout the house there is a marked preference for local lighting. Apart from one or two selected fittings in the reception rooms and the rather unusual alabaster fitting in the library, there are few ceiling fittings.

# Optics and Photometry at the N.P.L.

**This year the National Physical Laboratory celebrates its Jubilee. The following article deals with the work carried out by the Lighting Division, with particular regard to work on photometry and optics.**

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The Light Division of the National Physical Laboratory was formed in 1940 by the union of the optics section of the Physics Division and the photometry section of the Electricity Division. Descriptions of the photometric work carried out in the laboratory have appeared from time to time in earlier volumes of this journal\*, and shortly after the opening of the new photometry building in 1936 a description of it appeared in the Transactions of the Illuminating Engineering Society (Vol. 1, 1936, p. 148). There have, however, been no such publications regarding the optics section and its work, and it is therefore appropriate to begin with a description of this part of the Light Division.

Since 1913 the optical work of the laboratory has been carried on in what may be termed the "headquarters building" of the N.P.L., which was opened by A. J. Balfour in that year. This three-floor building houses the directorate and administrative offices, the library, the central clerical offices and the space used for the receipt and despatch of instruments sent for test, but about one third of the accommodation consists of laboratory rooms in which the various kinds of optical tests and the research work of the optics section are carried out.

On the ground floor there are two large rooms, one used chiefly for the tests made on sextants and gun-sights, while the other houses the instruments used for the absolute or comparative measurement of

radiation, not only in the visible spectrum but also in the ultra-violet and in the infra-red. The aspect of this work which is of most interest to the illuminating engineer is the determination of the spectral response curves of photocells and the measurement of their absolute sensitivity in microamperes per microwatt of incident radiation. The absolute sensitivity of thermopiles is



Fig. 1. Testing the angular scale of sextants.

also measured in this room and standards of radiation, usually filament lamps operated at a specified voltage, are calibrated.

The remaining room on the ground floor is smaller and is a constant temperature

\* C. C. Paterson and E. H. Rayner, *Illuminating Engineer*, 1, 1908, p. 845. H. Buckley, *Illuminating Engineer*, 20, 1927, pp. 174 and 197.

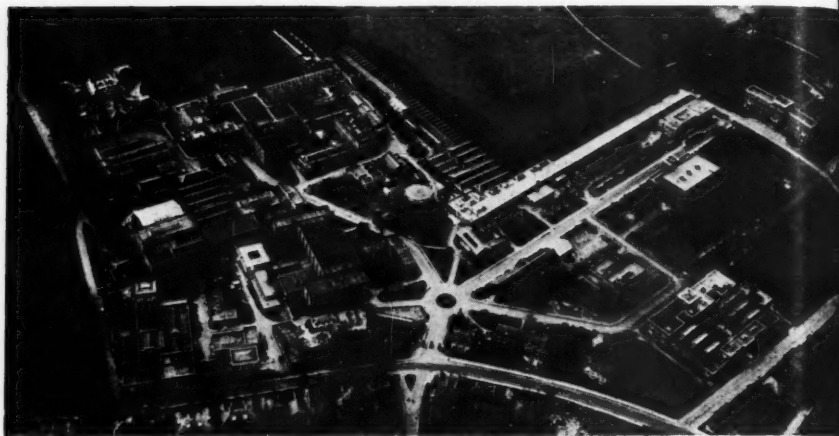


Fig. 2. Aerial view of the N.P.L.

room, heavily lagged and equipped with a thermostatic control by means of which the temperature can be kept constant to within a twentieth of a degree, or less. In this room the determination of the optical constants, such as refractive indices, of samples of optical glass or other materials is carried out to a very high degree of accuracy, if necessary to one unit in the sixth decimal place. A corner of the room and the high precision spectrometer used for the work are shown in Fig. 4. The dispersion of a glass, i.e. the change of refractive index with change of wave-length, is also determined. These two quantities, viz. refractive index and dispersion, are the characteristics of optical glass with which the lens designer is principally concerned.

#### Telescopes and Binoculars.

Of the two large rooms on the first floor, one looks across a field used as a sports field by the laboratory staff and the range thus available is used for the testing of telescopes, binoculars and similar instruments. At a distance of about a quarter of a mile there is a series of bold marks placed at one degree intervals as measured from a point in the telescope room. These marks are used in measuring the size of the field of a telescope or binocular, while the definition is estimated by viewing through the instrument a plate with small perforations of different sizes and shapes placed beside one of the marks. This test for definition is being replaced by a different

form of test which can be applied inside the building.

#### Lens Testing.

The testing of camera or other lenses is done on a universal lens interferometer by means of which it is possible to measure very small differences in the effective length of the path of the light passing through different parts of a lens and so to assess the quality of the image formed by it. The flatness of the surface of an optically worked plate can be tested by comparison with a standard flat and departures from flatness of as little as one twentieth of a wave-length, i.e. about one millionth of an inch, can be measured.

In photographic lenses the performance is greatly affected by light scattered at the various glass-air surfaces. A method of measuring the amount of this scattered light which reaches the image plane has been developed. Other tests on photographic lenses include the measurement of aperture ratio, or *f*-number, and the variation of illumination across the effective field. Camera shutters are calibrated in another part of the building, a photocell and cathode ray oscilloscope being used for the purpose.

Other optical instruments tested in the optics section are theodolites and levels, spectrometers, refractometers, polarimeters, saccharimeters, focimeters, spherometers and microscopes, while there is also equipment for measuring the absorption and reflection factors of materials and for determining the ratio of light diffusely reflected

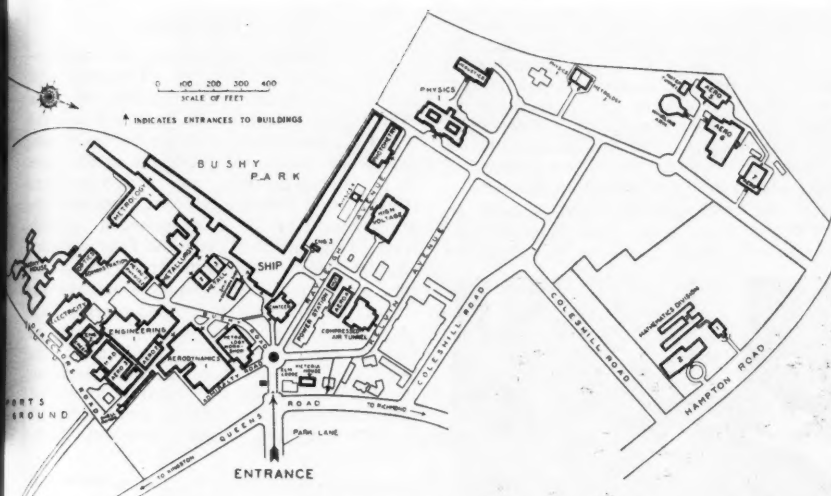


Fig. 3. Plan of the N.P.L.

to that specularly reflected. This ratio is used as a measure of the quality of a polished surface.

#### Colorimetry.

Much of the fundamental research which, later, formed the basis of the C.I.E. system of colorimetric measurement was carried out in the optics section of the N.P.L. during the years 1921-30, and one of the earliest of precise colorimeters, the Guild trichromatic colorimeter, was developed during this period. Lengthy and laborious determinations of the colour characteristics of the average observer were carried out at Teddington and the values obtained were combined with others determined at the Imperial College in arriving at the tables of the trichromatic coefficients of spectral radiation, in terms of real stimuli, which form the specification of the "Standard Observer" laid down in 1931 by the International Commission on Illumination (C.I.E.).

The Donaldson three-primary colorimeter, also developed at the N.P.L., is now extensively used in industry for all kinds of colour measurement, and every one of these instruments is calibrated in the optics section of the laboratory. This instrument is shown in Fig. 5.

A disadvantage of an instrument in which only three primaries are used is that with many modern sources of light the spectral distribution is very far from smooth,

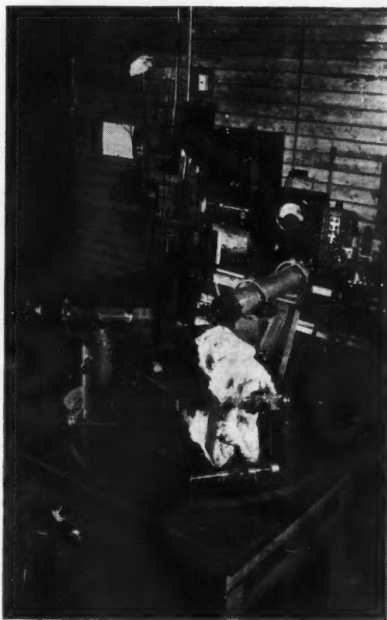


Fig. 4. A corner of the constant-temperature room with the precision spectrometer.

with the result that when a colour match is obtained in the colorimeter there may be marked differences of energy distribution, and so the results obtained may be different for different observers. In order to overcome this trouble a six-primary colorimeter has been designed, and this is available for colour measurements either on sources of light or on coloured reflecting surfaces.

All the work just described is done on the second floor of the building referred to earlier, and other rooms on this floor are

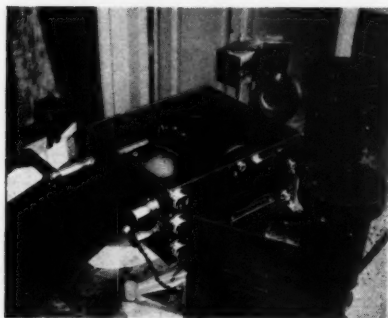


Fig. 5. (Above) The Donaldson colorimeter.

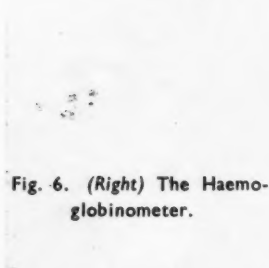


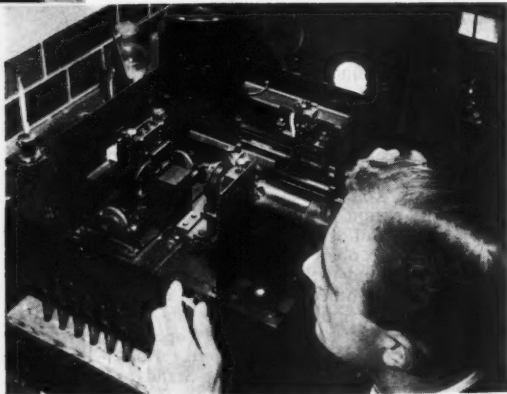
Fig. 6. (Right) The Haemoglobinometer.

used for various types of measurements involving colour or spectral distribution. For instance, one room houses the Hardy recording spectrophotometer, with which it is possible to obtain an automatic trace of a spectral reflection curve in a very short time. Spectrophotometry measurements are now almost entirely made with photo-electric apparatus and instruments of this kind, designed and built at the laboratory, are used both in the optics section and in the photometry section of the Light Division.

### Spectrophotometry.

One important application of spectrophotometry is to the study of neutral and coloured transparent filters, either of glass or gelatine. Most of the so-called neutral filters used in photometry are by no means free from colour, as is evident in the case of the higher densities such as two or three (transmission 1 or 0.1 per cent. respectively). Sometimes there is a pronounced reddish tinge, while in other cases the filter appears slightly green. Within the past few years the N.P.L. has collaborated with Messrs. Chance Brothers in the development of a glass which is a very great improvement as far as neutrality is concerned, and this glass is now available commercially and can be used to replace the neutral filters of gelatine which have hitherto given the best performance as regards freedom from selectivity.

Coloured glass filters for use in the visual measurement of discharge lamps, particularly sodium lamps, have also been developed in this section of the Light



Division, but for a number of purposes it is necessary to use liquid filters. These are employed to obtain the standard illuminants B and C of the C.I.E. system of colorimetry, and they are much used for correcting the sensitivity curves of photo-cells to the standard luminosity curve of the eye.

Research is in progress on the use of a dispersion and mask apparatus which, for fundamental work, is capable of giving higher accuracy than that obtainable with a colour filter. The type of mask is that one composed of a large number of narrow



Fig. 7. The Rotator used for deriving standards of luminous flux.

leaves, each occupying a small portion of the spectrum.

Spectrophotometry is not confined to the visible spectrum, but absorption measurements are often required in the ultra-violet and in the infra-red. In addition to such measurements on chemical substances in solution, filters for eye protection, e.g., in arc welding, are checked for compliance with the relevant specification.

An interesting application of absorption measurement is to the estimation of the haemoglobin content of human blood. This is the red oxygen-bearing component, and a measurement of its concentration in any particular sample of blood is of diagnostic importance. Instruments, termed haemoglobinometers (see Fig. 6), have been designed for making this type of measurement, and these instruments are calibrated on a scale set up and maintained at the laboratory, while estimations on blood samples are made for hospitals from time to time.

#### Glass-working.

Attached to the Light Division is a well-equipped instrument workshop for building the special optical apparatus needed, either for making tests such as those described above or for research. In addition there is a shop in which glass is optically worked to a very high precision. Several of the Lummer-Brodhun prisms used in the Division have been made in this shop,

which also undertakes the preparation of the glass colour filters needed for certain work, particularly heterochromatic photometry. These filters have optically worked surfaces, and their thickness is specified to very fine limits.

In another part of the Division there is equipment for the deposition of very thin films of metals on glass or other surfaces. Two processes are used, viz., cathodic sputtering and evaporation, both in a high vacuum. The principal applications are to the preparation of semi-reflecting surfaces on glass and to the surface coating of photovoltaic cells.

#### Photometric Standards.

The N.P.L. is responsible for the maintenance of the photometric units in this country, and so the work of the photometric section of the Light Division rests, ultimately, on the standards used for this purpose. The now internationally adopted primary standard has often been described before.\* Briefly, it consists of a hollow enclosure of refractory material immersed in molten platinum of a high degree of purity. The brightness of a tiny opening in this enclosure when the platinum is at the temperature of solidification is 60 candelas per sq. cm., the candela being the international unit of luminous intensity. The heating of the platinum is carried out

\* See, e.g., *Trans. Illum. Eng. Soc. London*, 5, 1940, p. 89.

by means of a high frequency induction furnace, and suitable tungsten filament lamps, under-run to a colour match with the standard, are measured in terms of the unit thus established. As the colour temperature is low, these lamps are used in combination with a bluish glass colour filter to measure other lamps at higher colour temperatures. Further, in order to obtain standards of luminous flux, vacuum lamps of suitable filament design are measured, while rotating, in a number of different directions so that the average value of the luminous intensity in all directions in space can be found. This rotator is shown in Fig. 7. Finally, other lamps are measured by comparison with these sub-standards of flux in an integrating sphere, and thus the laboratory's working standards of luminous flux are obtained.

As a check on all this work and in order to ensure that, as far as possible, the units have the same values in all countries, lamps which have been aged and proved constant are measured, some for luminous intensity, others for luminous flux, and these are sent to other national laboratories or to the Bureau International des Poids et Mesures at Sèvres for an inter-laboratory comparison. The measurements involved in all the work thus described are made to the highest precision normally attainable, of the order of one part in 1,000, although the estimated absolute accuracy of the values obtained is considerably less than this owing to the number of steps involved, including one or two stages of heterochromatic comparison.

Apart from this fundamental work, the photometric measurements made on lamps consist of determination of the luminous intensity in a specified direction, or of the luminous flux, for lamps sent to the laboratory. Some of these lamps are intended for use as standards in some other laboratory or test room and such lamps are first carefully aged for periods up to 100 hours to prove their stability. They are then measured on several different occasions and values are assigned to them to an accuracy which varies with the type and size of lamp. The highest accuracy normally given is  $\frac{1}{4}$  of 1 per cent. Other lamps, not intended for use as standards, are measured to a "commercial accuracy" of some 1 to 2 per cent., again depending on the type of lamp. The accuracy assigned to flux measurements on ordinary types of discharge lamps is not so good, owing to the energy and colour differences involved in the photometry, and is usually about 3 per cent.

Any reduction of this figure can only be

achieved by increasing the accuracy of the heterochromatic photometry involved.

### Heterochromatic Photometry.

Visual photometry with a colour filter which gives a sensation colour match with the tungsten filament working standards is of strictly limited application, since there is generally a considerable difference of energy distribution and the results obtained therefore depend on the visual characteristics of the observer.

The flicker photometer can be used in certain cases and the form of instrument developed at the laboratory some time ago, the Guild flicker photometer, is then employed. Flicker photometry under the standard conditions of field size is, however, very tiring to the observer if the work is at all prolonged and attempts have been made to apply a colorimeter to photometric measurement. The three-primary instrument is open to the objection, mentioned earlier, that differences of energy distribution result in considerable discrepancies between observers, but it is hoped that this difficulty may be largely overcome by the use of the six-primary instrument and one of these is being made for the photometry section of the Division.

Routine photometric measurements are made photo-electrically using a photo-emissive cell and correcting filter. For lamps up to 150 watts flux measurements are made in an integrator of one metre in diameter (see Fig. 8); larger filament lamps, fluorescent lamps and fittings are measured in the 10-ft. sphere shown in Fig. 9. Except in the case of discharge lamps, the supplies used are from large storage batteries. Discharge lamps are run on a regulated a.c. supply.

Apart from the photometric measurements made on lamps, life tests are run on a supply regulated for voltage to about 0.1 per cent. and the auxiliary tests called for in the B.S.I. Specification, e.g., the torsion test, checking of overall dimensions and of light-centre length and the insulation resistance measurements, are carried out as required.

### Tests on Fittings and Lighting Apparatus.

The measurements made on fittings include efficiency (or, better, light flux ratio), light distribution and, in some cases, the distribution of illumination over a working plane, specified in relation to the fitting. For small and medium sized fittings, the light distribution is determined by means of mirror apparatus in which the fitting moves around

the mirror in a vertical plane, as shown in Fig. 10. For large fittings illumination measurements are made at various angles from the downward vertical. The iso-candle diagram of a street lighting or similar fitting is plotted in this way.

Other routine tests which may be mentioned here are those on ships' navigation lights (oil-burning) and on rear reflectors for

flector, illuminated by an automobile headlight of specified luminous intensity, is required to have a reflected luminous intensity of one-thousandth of a candela over a range of angles of view and for a range of angles of tilt with respect to the headlight beam. Measurements are made by comparing the test reflector with a pair of mock reflectors, one on each side of it, of controlled and known luminous intensity.

Other tests carried out from time to time include those on "anti-dazzle" devices for modifying the light distribution from the beam of a headlight, on daylight or night signalling lamps, reflector buttons for advertisement signs, etc.

Illumination photometers are regularly sent to the laboratory for a check of the scale calibration. Most of these instruments are photo-electric and the tests asked for sometimes include a check of the constants or range-changers provided for



Fig. 8. (Above) The one metre integrating sphere.



Fig. 9. (Right) The 10 ft. integrating sphere.

bicycles. The former are, in most cases, type tests for Ministry of Transport approval; they include a thorough check of mechanical dimensions, a test of luminous intensity over a specified period for the lamp and a determination of the light distribution particularly in the vertical plane, of the complete lantern with lens. The coloured slides of the port and starboard lanterns are also tested.

Rear reflectors are tested for the manufacturers, to check compliance with the Ministry of Transport Regulations. The re-

measuring the illumination from sources other than tungsten lamps.

For work in which illumination measurements are involved, the photometry section generally makes use of a type of semi-portable visual illumination photometer originally developed some time ago. It is of the pattern in which a lamp, in a small housing, can be moved along a metal tube at one end of which is a diffusing window, Lummer-Brodhun comparison cube and eyepiece. The instrument is considerably

larger than that normally used for work "in the field," portability having been sacrificed in order to use a larger lamp and so attain greater accuracy than can generally be secured with a really portable instrument.

Instruments for measuring luminance (brightness) are also calibrated and the reflection factors of diffusing surfaces are determined by comparing them with a standard surface which has been measured by an absolute method.

There are two types of tests in which the measurement of very low values of luminance is involved. In the case of the adaptometers used for testing night vision it is necessary to measure the luminance of an extended surface down to or below the limit of visual sensation. Needless to say, this can only be done photo-electrically though it is usual to make visual measurements as well at the higher values, to provide an overall check on the work. The values given are those of "equivalent luminance," i.e., the luminance, expressed in foot-lamberts, of a surface which has the same colour temperature as the primary standard (viz., 2042 deg. K) and which appears to have the same luminance as the adaptometer surface.

The other test dates from the 1914-18 war, when a large number of aircraft and other instrument dials, figured in radioactive luminous compound, were sent to the N.P.L. for a check on the luminance of the markings. The instrument then developed at the laboratory for making this test was copied and subsequently passed into general use for checking luminous dials. A considerable number of such instruments are now in use, both by manufacturers and by the Services, and these instruments are sent to the laboratory periodically for checking and recalibration. Measurements of luminance are also made from time to time on the luminous compound used for the markings.

#### Colour Temperature.

The colour temperature of a light source is defined as the true temperature of a full radiator (often called a "black body"), which exactly or very nearly matches it in colour. A full radiator is generally realised in the form of a small aperture in a hollow enclosure of uniform temperature (the primary standard of light described earlier is such a radiator at the temperature of solidification of molten platinum), and the energy distribution from such a radiator is completely defined by its temperature, using Planck's radiation formula. Since the energy distribution from a tungsten filament lamp

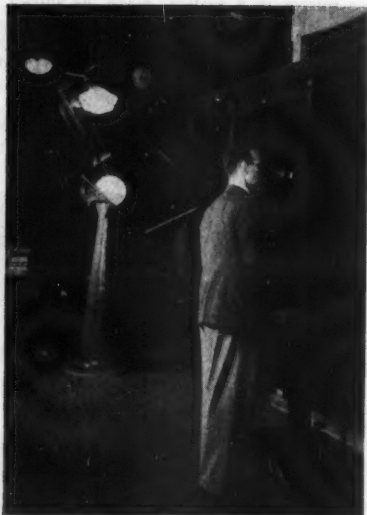


Fig. 10. The mirror apparatus for determining light distribution curves.

is, at any rate in the visible spectrum, a very close approximation to that given by a full radiator at some temperature or other, such a lamp forms a very convenient means for maintaining the colour temperature scale, and, in fact, a number of carefully aged lamps are used for the purpose. These lamps have been compared visually with a full radiator whose temperature has been measured with an optical pyrometer using a Lummer-Brodhun photometer head for making the comparison. The voltage at which a lamp exactly matches in colour the radiation from a full radiator at any observed temperature is determined for a number of such temperatures, and so a calibration curve for that lamp, giving the colour temperature at any voltage within the range covered, can be drawn. This has been done for a number of lamps, and the scale is based on a group of lamps so calibrated.

It will be seen that the temperature range which can be covered in this way cannot extend above the point at which the lamp can be operated without fear of deterioration, and, in fact, an even lower limit is set by the accuracy with which the measurements of temperature can be made. As a result, while the scale has been established by direct comparison with a full radiator up to a temperature of about 2500 deg. K., for higher temperatures a liquid colour filter is used in com-

bination with a lamp calibrated as described above.

Experimental work is now in progress to investigate the possibility of determining the colour temperature of a source by measuring the ratio of the radiation emitted in two or more narrow wave-length bands at different parts of the spectrum.

### **Illumination Research.**

As part of the programme of work carried out for the Illumination Research Committee of D.S.I.R.,\* investigations of various problems of vision have been carried out in the photometry section ever since 1924. These have resulted in a considerable increase in our knowledge of the phenomena of glare and of the behaviour of the eye under conditions of dark adaptation. It was this work that led to the discovery of the Stiles-Crawford effect, i.e., the fact that the eye differs from a camera in that the effectiveness of light entering the lens near the edge of the pupil is much less than that entering near the centre. Work is now being done on the colour sensitivities of the retina of the eye, particularly the central part, where vision is most acute, the fovea.

It is well known that the spectral sensitivity curve of the eye is not the same under conditions of dark adaptation as it is at ordinary working values of illumination. A curve for the light-adapted eye, based on a considerable bulk of experimental work, was adopted internationally in 1924, but the curve for the dark-adapted eye is less well established and a careful determination of it has been carried out at Teddington during the past few years. It is expected that the values obtained will, in combination with some values available from other sources, enable the I.C.I. to adopt a "standard" curve in 1951.

As a result of a resolution passed by the International Commission on Illumination at its last meeting, plans are now in hand to determine the tristimulus values of spectral radiation for the average observer in terms of three spectral lights as matching stimuli. As mentioned above, the data adopted by the Commission as the basis of the C.I.E. system of colorimetry were based on work carried out before 1931, and it is considered that a redetermination on a large number of observers should now be made under improved conditions and in the light of knowledge which has accumulated since that time.

### **Daylight.**

A not inconsiderable part of the work carried out for the Illumination Research Committee referred to above was concerned with problems of daylight. Most of this work was published in the Illumination Research Technical Papers, one of which (No. 17) summarised the daily records of illumination received from the sky at Teddington and measured visually three times a day from 1923 to 1933. After that date photo-electric apparatus giving a continuous record of the daylight illumination was installed, and records were accumulated for the five years between 1933 and 1939. The analysis of these records was a laborious process and was interrupted by the war, with the result that no publication corresponding to that of the visual records has been possible. However, curves showing the average illumination received from the sky throughout the day have been prepared for each month of the year, and it is expected that these will be included in a forthcoming Report on the Lighting of Offices, to be published as one of the Post-War Building Studies of the Ministry of Works.

### **International Relations.**

When the International Commission on Illumination was formed in 1913 from the original International Commission on Photometry, the secretariat and central bureau of the Commission was located at the N.P.L. This arrangement continued and the general secretary of the I.C.I. was a member of the staff of the photometry section until the transfer of the central bureau to the U.S.A. in 1948.

Apart from this work and the international co-operation involved in the inter-laboratory comparison of standards referred to earlier, contact is constantly maintained with workers in other optical and photometric laboratories throughout the world. Outstanding examples of this have been recent visits from members of the staffs of the Institut d'Optique in Paris and of the Instituto del Optica in Madrid, who have each spent several months in the photometry section, joining in the visual research there in progress.

### **New Street Lighting**

Last month electric street lighting was switched on for the first time in Pontefract. The scheme provides for the lighting of Southgate by 37 mercury 250-watt lamps. Southgate is a Class "A" road of dual carriageway and the lamps are attached to existing steel columns in the centre of the road.

\* Illum. Eng., 19, 1926, p. 193.

## Manufacture of Lighting Fittings

The work of the manufacturer of lighting fittings to-day has become an exacting and complicated engineering science, whilst the application of his products has more than ever to be scientifically planned.

For more than 40 years the Benjamin Electric, Ltd., has set out to supply the best possible equipment for use with tungsten filament, discharge and fluorescent lamps. For this reason we are pleased to be able to describe a tour of the company's two factories at Tottenham.

The order of the tour was arranged to follow through the whole manufacture of reflectors, from the raw material stage to their finished form and ultimate dispatch.

In the raw materials store incoming deliveries of all types of material are fed to storage racks by an overhead runway and electric crane. In addition, in this store, sheets of steel, aluminium, brass and copper, etc., are cut by guillotine machines to the correct size and shape required by the

**This article describes the various stages of the processes used in the manufacture of metal reflectors and other types of lighting fittings at a particular factory.**

various shops. These "blanks" pass to the press shop, where lines of presses of various types and sizes shape the sheet or disc to the shape of the lighting fitting, the round blanks receiving as many as a dozen pressing operations before achieving their final shape. During these operations, careful annealing has to be carried out from time to time. Before vitreous enamelling, edges are trimmed and the beads formed at the same time, wrinkles and stresses being ironed out by a rolling operation.

In another section of this shop, sheet steel is being formed into "Fluorolier" fluorescent troughs. For these forming operations the works is equipped with large "brakebend" machines which can be set up with a multitude of different tools to carry out the



The raw materials store, showing steel blanks and circles and non-ferrous strips in rolls.

Part of the press shop, showing the double action drawing presses and tungsten reflector black shapes in various stages up to final form.



intricate and accurate operations involved in the manufacture of the various trough fittings. Great care is taken in the welding of the ends into the troughs and the cleaning of the joints, this being done by hand to ensure that the final vitreous enamel surface has a perfect finish. Although inspection is carried out at all stages of the process, the "Black shapes," before reaching the vitreous enamelling shop, pass through a final inspection.

Other sections of the press shop are engaged in the manufacture of small metal parts for lampholders, interiors of "Saafux" fittings, and all other small assemblies.

Probably one of the most interesting processes at this works is the vitreous enamelling. Before enamelling, surfaces are prepared to receive the enamel by passing all the reflectors through a modern degreasing, cleaning and pickling section. An adjacent section, the mill shop, is equipped with revolving steel drums, porcelain lined, and carrying 1,000-lb loads, in which the various raw ingredients are mixed to accurate formulae and ground to usable form. The enamel "slip" is then issued out to the main shop, where the reflectors may be sprayed or dipped into baths of it. Each reflector received three coats of enamel and has to go into furnaces to be "fused" at about 800 deg. C. between each coat. In view of the strict control of



Testing fluorescent chokes for efficiency and checking to standard.

the processes at all stages, the high quality of this "Crysteel" vitreous enamel is not surprising.

A 12-ft. integrating sphere is used in the engineering laboratory to test the fittings picked at random from the finished batches, thus ensuring the maintenance of a high standard. Other finishing processes are also

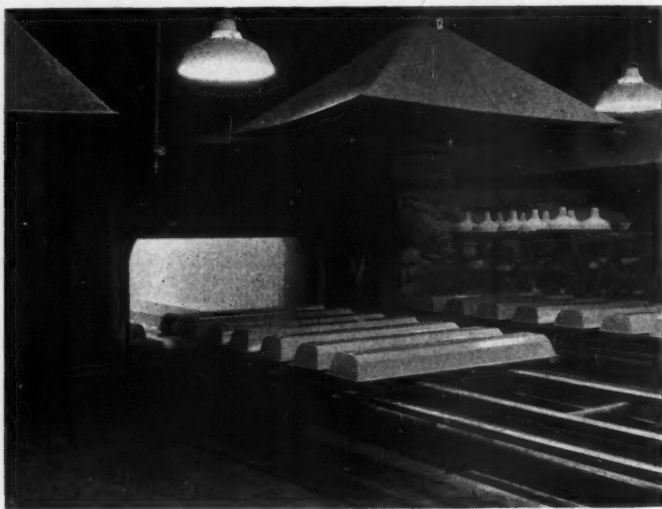
carried out at the Tottenham works, including aluminium anodising, cellulose spraying, store enamelling, and metal polishing. As an anti-corrosive measure, all metal parts are either plated or bonderised before cellulosing.

After going through the appropriate finishing operation, the various components are ready for final assembly into lampholders, "Saafux" interiors, fluorescent wiring channels and the like, and for this

assembly work. After inspection, these small components are packed into cartons and pass on to the finished stores, where they meet up with their respective reflectors.

In the "Fluorolier" assembly section, up-to-date methods of assembly are used. After test on a panel specially designed and built up by the engineering and research department for this purpose, all the gear and components pass to the various operators on long conveyor lines. The empty shells

Showing one of the furnaces in the vitreous enamel shop and a load of fluorescent troughs after firing.



the assembly department is divided into two parts, lampholders and tungsten assemblies, and fluorescent fittings.

The large variety of lampholders and fluorescent components are assembled entirely by girls who, as is well known, are more adaptable for this type of small

of wiring channels start their run at one end and, on reaching the other, are completed "Fluoroliers" ready for immediate service. In fact, every one, before packing and dispatch, in the course of its final inspection has a lamp installed and is operated as part of the final test.

### British Industries Fair

The 1950 British Industries Fair is to be held from May 8-19. As in previous years, the Engineering and Hardware Section will be at Castle Bromwich, Birmingham, where the following firms are amongst those exhibiting lighting equipment:—

Auto Diesels, Ltd.; Berry's Electric, Ltd.; The British Thomson-Houston Co., Ltd.; David Brown Gears (London), Ltd.; The Co-operative Wholesale Society, Ltd.; Davis Sheet Metal Engineering Co., Ltd.; Ekco-Ensign Electric, Ltd.; Electro Mechanical Manufacturing Co., Ltd.; Hailwood and

Ackroyd, Ltd.; Liverpool Electric Cable Co., Ltd.; Longlamps, Ltd.; Joseph Lucas, Ltd.; William McGeoch and Co., Ltd.; Metway Electrical Industries, Ltd.; A. C. Morrison (Engineers), Ltd.; Newage (Manchester), Ltd.; Oldham and Son, Ltd.; Osborn Manufacturing Co., Ltd.; Parmeko, Ltd.; Partridge, Wilson and Co., Ltd.; Harry J. Pratt and Co., Ltd.; Revo Electric Co., Ltd.; Thorn Electrical Industries, Ltd.; Walsall Conduits, Ltd.

"Triplex" Safety Glass Co., Ltd., is believed to be the only exhibitor of lighting equipment at the Earls Court Section.

## French Scientific Instruments

**The exhibition of French scientific instruments at the Science Museum, South Kensington, which terminated on February 26, marked an encouraging development in technical exchanges between nations.**

The exhibits were not of historical interest: they were a selection of the most recent productions of French inventors and research workers and of French manufacturers, private or Government-sponsored. A suitable exhibition gallery and facilities were made available by the Director of the Science Museum, and the project was supported on this side of the Channel by the Royal Institution. The French bodies exhibiting included the Commissariat à l'Energie Atomique, the Centre National de la Recherche Scientifique (C.N.R.S.), the Institut d'Optique, the Office National des Etudes et des Recherches Aeronautiques. The optical instruments, with which this review will be mainly concerned, represented only a small part of the whole.

The neat application of simple geometrical ideas, always attractive in an instrument, was well illustrated by the Universal Gloss-meter (C.N.R.S.) by which the reflection of a sample for any angles of incidence and view can be measured. The sample is placed on a horizontal table, rotatable about a vertical axis. The light reflected from it in any direction in a fixed vertical plane through this axis falls first on a small mirror mounted tangentially on an elliptical metal arc, and then on a photocell. The foci of the elliptical arc are occupied respectively by the specimen and the photocell, the latter being fixed to the pivoted end of a rod which extends past the mirror with which it is in sliding contact. Thus, as the mirror is slid round the arc to vary the angle of view, the rays it receives from the specimen are always reflected towards the photocell and the latter is always turned to receive these rays normally. A similar arc device is used to obtain various angles of incidence, except that a small light projector replaces the photocell and the arc with projector, etc., rotates as a whole about the vertical axis

through the specimen to enable the angle between the planes of incidence and view to be varied. Identical angles of incidence and view can be used by replacing the photocell mirror, which in the case considered lies directly between the projector mirror and the specimen, by a half-reflecting, half-transmitting plate.

Another simple geometrical principle is embodied in a panoramic camera (C.N.R.S.) which gives, at one exposure and without sweeping, a photograph of the whole 360 deg. of horizon over a vertical band-width of 20 deg. Two highly polished cones are mounted on a common vertical axis with their apices opposed and separated. Between the cones is placed a plane horizontal diaphragm perforated with a pinhole at the point where it is intersected by the vertical axis. The photograph is formed by rays from the distant horizon which after reflection by the upper cone, pass through the pinhole and are reflected by the lower cone on to a strip of film lining a cylindrical surface coaxial with the cones. Among the applications of this camera indicated were the study of insolation in regions of low contour and the photography of lightning flashes.

Exceptional freedom from parasitic light is the feature of an interesting monochromator employing only one optical element, which was shown by the C.N.R.S. and the Institut d'Optique. The prism of this instrument has spherical side surfaces, the rear one being silvered. Light from an entrance slit is refracted by the front surface, reflected by the rear surface and re-refracted by the front surface so that rays of different wavelength are focused at slightly different distances from the prism. Thus by means of a suitably placed exit slit a beam of one wavelength is isolated.

Among the latest versions of familiar optical instruments—microscopes, refractometers, etc.—which were on view may be mentioned a telescope (C.N.R.S. and I.d'O.) of power 10 and having the exceptionally large image field of 92 deg. To achieve this without excessive curvature of field, two reflections are introduced between objective and eyepiece, one of these being at a Mangin mirror (lens silvered on one surface).

A recording microphotometer (C.N.R.S.)

and a flash cinespectrograph (C.N.R.S. and Institut de Radium) provided examples of more elaborate instruments. The latter enables the absorption spectrum of a liquid to be measured repeatedly at the rate of 50 determinations a second, each determination being obtained in the flash of duration  $10^{-4}$  sec., or less, given by a flash discharge in xenon. The main application in view is to follow the changes in concentration of differently absorbing reactants in rapid chemical processes.

The micro-brightness meter for the study of phosphorescent surfaces, shown by C.N.R.S., is a visual instrument using normal (non-Maxwellian) binocular observation of a 10 deg. matching field with aperture control of intensity. The aperture is formed by the intersection of a fixed slit with a slot in a quadrant diaphragm. As the quadrant is turned, the width of the slot exposed increases logarithmically over a range of 1 to 100.

Of interest to those concerned with the rapid testing of refractive error was an optometer (C.N.R.S. and I.d'O.) which, in effect, presents simultaneously to the examinee's view nine identical test patterns at different viewing distances. A very compact ophthalmoscope, shown by the same establishments, used a totally internally reflecting prism of special form to project the illuminating beam into the eye.

The diameter of the halo of diffracted light formed when a parallel beam passes through a layer of small particles depends on the particle size, and this principle is turned to account in the haemodiffractometer (Optique et Precision de Levallois), an instrument for determining the average size of blood corpuscles and the spread in this size.

When the variation of a quantity, for example, the candle-power of a light source at various angles, is obtained as a linear displacement of the spot on a cathode ray oscillograph, it is sometimes convenient to have the results recorded as a polar curve. C.N.R.S. showed a simple device for doing this. It consists of a rotating camera which can be fitted to any normal c.r. oscillograph the axis of rotation being set off the centre to make the fullest use of the displacement available on the screen.

Mentioned in the catalogue, but not on view, was a device to be placed on the stage of an ordinary microscope to convert it to a phase contrast instrument. It was stated that this device would be available in a few weeks (C.N.R.S. and I.d'O.).

The non-optical exhibits included, among

much else, electronic calculating machines, a mass-spectrograph and a wide selection of instruments used in determining the mechanical properties of solid and liquid substances of industrial importance.

## Building Research Congress

A comprehensive Congress on Building Research is to be held in London from September 11 to 20, 1951, and will be the first of its kind ever to be held. It will mark the rapid developments in building science made since the end of the war and has been arranged because of the great and growing interest shown in the subject in many countries.

The Congress is sponsored by the British professional institutions and learned societies interested in building science, and by government departments, with the support of representative industrial federations in Great Britain. The Department of Scientific and Industrial Research is providing the central organisation for the Congress. Papers are being invited from research workers in many countries on a wide range of topics, and arrangements are being made to welcome to the Congress a large number of visitors from overseas.

The purpose of the Congress will be to review the progress made in research in relation to architecture, building, and the associated branches of civil engineering. The papers presented will deal with recent research and its influence on modern development and will include papers on the effect of summer and winter conditions on the heating and cooling of buildings; the lighting of buildings; problems of special types of buildings, particularly schools, hospitals, and factories; the acoustics of auditoria and broadcasting studios.

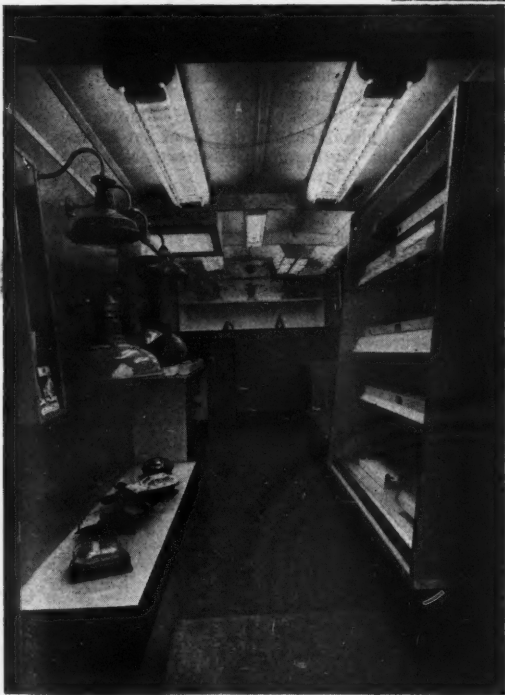
The Congress will be organised in three divisions which will hold concurrent meetings. Visits to buildings of interest and to civil engineering works, etc., will be arranged during the period of the Congress.

Announcements of detailed arrangements will be made in due course, but those interested are advised to notify the Organising Secretary as soon as possible in order that detailed information may be sent direct. The Organising Secretary, Building Research Congress, 1951, Building Research Station, Bucknalls-lane, Garston, Watford, Herts.

## Mobile Showroom for Lighting Fittings

To provide facilities in areas where it is not always convenient to visit one of their showrooms, Crompton Parkinson, Ltd., now have a mobile showroom equipped with representative lighting fittings.

By skilful planning the showroom has been arranged to contain more than thirty different types of lighting fittings. One of the latest trends in lighting shown is the Crompton "Louvalite," screening fluorescent lamps to provide a comfortably diffused and pleasant form of general lighting. A complete section of the lattice construction is installed. Other examples of the Crompton range of decorative lighting fittings include ceiling types with decorative panels of translucent material, and in some cases



incorporating lattice louvres. There are also fluorescent fittings for shop window and display lighting, and a demonstration of the method of recess lighting for mirrors. A variety of types of reflectors for industrial lighting either by fluorescent or filament lamps are now available for inspection.

The "Louvalite" and the decorative fittings are mounted on the ceiling, equipped with fluorescent lamps and wired up for connection to a convenient electricity supply, so that the actual illumination obtained in practice can be demonstrated.

To provide for different supply voltages a "Variac" transformer control is installed and it can be connected to any electricity supply from 200 to 250 A.C. volts to give an output of 230 volts.

The interior of the showroom is finished in sycamore and mahogany veneer, with seats and shelving covered in brown plastic material manufactured at the cable works of Crompton Parkinson, Ltd.

## Recent Street Lighting Installations

The illustration on the right shows an installation at Clydebank of Revo street lighting fittings (C. 12664) using 140-watt sodium vapour lamps. The fittings are spaced at distances of approximately 140 ft. and the height to light centre is 25 ft. The particular fitting used comprises a cast aluminium canopy and ends with internal reflector system specially designed for use in conjunction with prismatic glass panels. Highly effective utilisation of the total light is obtained whilst only a small percentage of the lantern output is emitted above the horizontal.

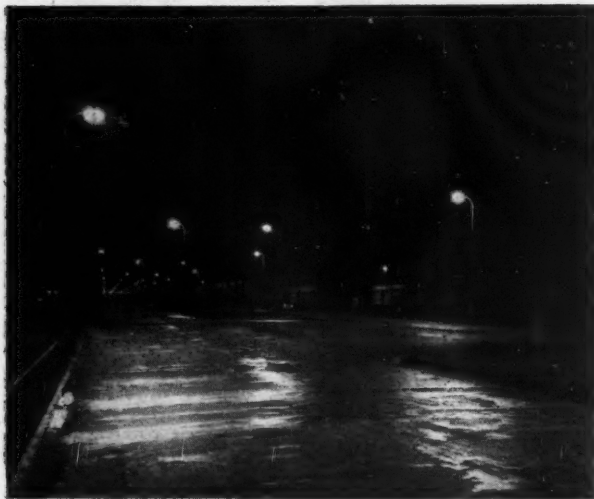
A new installation for Haltemprice U.D.C. of Metrovick "S.O. Fifty" lanterns covers  $1\frac{1}{2}$  miles of class "A" roadway which forms the main thoroughfare into Hull from the south and west. The installation consists of 115 lanterns, using 140-watt Sodium dis-

charge lamps on 25-ft. narrow-based concrete columns with 2-ft. 3-in. side entry brackets, spaced at 130 ft. Metropolitan-Vickers were the main contractors for the complete installation.

A scheme of B.T.H. fluorescent street lighting has recently been put into operation in Northumberland-street, Newcastle-upon-



(Above). Sodium lighting at Clydebank.



(Left). Sodium lighting at Haltemprice.

Fluorescent lighting at  
Newcastle-upon-Tyne.



Tyne. This is the principal thoroughfare in the city, and a part of the A.1 road. The installation consists of 25 fluorescent street-lighting lanterns (No. SL750), the 3-lamp fittings which have been used in other successful roadway lighting schemes, 5-ft. 80-watt fluorescent lamps providing the light source. The units are mounted opposite each other on tram standards on each side of the road, spacing being at 110 ft. intervals. The corporation engineer designed the installation, and lighting engineers from the B.T.H. Newcastle office advised in regard to siting. The excellent

level of illumination achieved may be judged from the accompanying illustration.

Another recent fluorescent street-lighting scheme is at Ebbw Vale, South Wales. All the equipment for the installation was supplied by the General Electric Co., Ltd., and comprises 33 "Four-Eighty" lanterns, each with four 5-ft. 80-watt fluorescent lamps, 33 steel standards of special design and the associated gear. The lanterns are mounted at a height of 25 ft. on standards spaced 150 ft. apart. The road width averages 22 to 30 ft., and the illumination provides 8,100 lumens per 100 ft. linear.

Fluorescent lighting  
at Ebbw Vale.





## Street Lighting by Gas

Recent gas street lighting installations have demonstrated many notable improvements, and this is not surprising in view of the fact that the gas industry, which is responsible for about half the public lighting in this country, has always shown itself very conscious of its duty in providing a service to the public which is one of the most important amenities of life in town and village.

Not only the gas supply industry but the manufacturers of gas street lighting equipment have, during the past 100 years, devoted considerable time and experience to providing the community with the lighting it requires at the lowest possible cost. The fact that many gas street lighting installations which have served the public for 50 years or more are still mechanically sound is eloquent tribute to the excellent use which has been made of the experience and knowledge gained.

Because of the emphasis placed by local authorities on durability in equipment bought with public money, many of the lighting installations still retained in service are obsolete in comparison with modern lighting standards, with the result that the public may have quite a wrong impression of the effect to be obtained with the more

**Visitors from overseas, making their first visit to this country, are often surprised at the high standard of gas street lighting. This article describes some of the apparatus used in recent installations.**

recent gas street lighting equipment. Although everyone crossing London Bridge at night cannot but admire the new gas lighting installation which lights the bridge to a very high standard, how many realise that the new lamps use only a very little more gas than the old?

Many of the changes which the practice of street lighting has undergone of late may be traced to the Report of the Ministry of Transport Street Lighting Committee in 1937, although the extent to which advantage has so far been taken of the Report has been limited first by the interruption caused by the war, and more recently by restrictions on capital expenditure. Nevertheless, the general findings of the Report may be regarded with confidence.

Experience and knowledge gained since

(Above). A main road installation at Southport.

publication of the Report will be embodied in a proposed code of practice and this, it is hoped, will serve as a very useful tool for the confident tackling of large-scale improvements by those entrusted with the responsibility for the administration, design, and maintenance of street lighting.

While realising the need for better lighting, the gas industry has also borne in mind the desirability of keeping capital costs low and reducing maintenance labour charges. Indeed, so important is the incidence of high labour charges that special consideration has been given to the whole question

which has recently taken place has reduced to some extent the number of models available and has taken advantage of the principles of standardisation and inter-changeability of parts where possible. This, it is hoped, will meet with the approval of lighting authorities.

The relighting of London Bridge, referred to earlier, was carried out—appropriately enough—with “London” lamps, supplied by William Sugg and Co., Ltd., Westminster (see Fig. 2). The “London” lamp, which is, indeed, widely in use throughout the country, is fitted with 10 or 12 No. 2 mantles in a



Fig. 2. London Bridge with the new gas lighting installed last year. The mounting height is 25ft.

of the amount of attention required by installations if a high standard of lighting is to be maintained, and as a result many notable improvements have been made in this direction.

The design and appearance of street lighting equipment is, perhaps, of greater importance than ever, because, although dictated primarily by technical considerations, with the closer spacing and greater mounting heights now recommended, the columns and lamps tend to dominate the scene. In keeping with the common desire to improve the aesthetic appearance of street furniture, the gas industry has submitted designs to the Royal Fine Art Commission which have now been approved.

The degree of rationalisation in design

horizontal line source. A high degree of control is exercised over the light distribution by the use of three silvered glass reflectors, mounted as a unit on each side of the burner. Each reflector unit is pivoted at a point corresponding to the light axis of the source and is adjustable up or down over several degrees. This lamp is therefore able to provide Type 1 or Type 2 distribution at will and can readily be set to deal with gradients or change of gradients. A suitable spacing for the “London” lamp is 120-150 ft. staggered formation, with a mounting height of 22-25 ft. A smaller “London” lamp, using eight No. 2 mantles, is also available and has proved very useful for a medium-powered source.

Another product of William Sugg and Co.,

Ltd., is the "Southport" lamp, a double-unit lamp also recommended for Class "A" lighting. A very powerful unit for shopping centres, etc., it is usually set with Type 1 form of light distribution to give good surface brightness. Its maximum intensity of some 4,000 c.p. emitted from a comparatively large area gives excellent results without undue glare.

A characteristic of this lamp is the use of diffusing or prismatic glass all round, the prismatic surfaces being covered with smooth glass to facilitate maintenance. The desired form of light distribution is achieved principally by the specially designed Holophane refractor plates and the prismatic glass bottom, there being no internal reflectors apart from the white enamelled top reflector. The lamp is particularly adapted to midnight reduction, as it has two separate burners.

Maintenance cost of the "Southport" lamp has been found to be particularly low. Exceedingly reliable operation has been obtained by the incorporation of a special burner system using the "Aeromatic" dual injection principle. Mounting arrangements for the lamps are such that they can be fixed to existing columns, the result being a particularly neat-looking installation.

During the past year or two the gas industry has paid special attention to the lighting of Class "B" roads, feeling that they have been somewhat neglected as a result of the great deal of design effort put into main road lighting.

Not the least part of the complex problem of lighting "other roads" is the very wide variety of conditions which occur in practice, but in the average community the wide use of well-planned medium or high-level Group "B" lighting schemes will provide a good public service at reasonable capital and annual cost.

The recent study of Group "B" lighting

by the gas industry has embraced every aspect of the problem, including the question of the desirable forms of light distribution, the treatment of each type of road, the design of equipment to conform to varied surroundings, and the detailed investigation of all matters appertaining to capital and maintenance costs, as a result of which outstanding economies have recently been made possible.

The Group "B" "Southport" Lantern, manufactured by William Sugg and Co., Ltd., is illustrated in Fig. 3. In this lantern the light output of the burner is redirected by the use of Holophane refractor plates, specially designed for this lantern, which distribute the light in two widespread fan-shaped beams normally directed 10 deg. below the horizontal, but which can be set at a lower angle if desired during manufacture. The maximum candle-power of the lantern is up to 1,500 c.p., according to size of source. The bottom glassware is also prismatic and assists in producing an even shadowless illumination in the neighbourhood of the column. The ends of the lantern are glazed with a fluted glass chosen for ease in cleaning, and prism surfaces of the refractor glasses are covered with a thin sheet of toughened glass for the same reason. The use of this diffusing glassware results in a particularly attractive lantern appearance, both by day and night.

Among lamps which adequately provide for the many characteristics of Group "B" thoroughfares are the "Maxilla" gas street lanterns supplied by Parkinson and Cowan, Ltd., Birmingham. These are improved versions of the "Maxilla" lanterns widely used before the war, their main feature being rationalisation in design. They are all identical except for burner and reflector assemblies, having the same hood, body, frog and controlling devices and may, therefore, be installed conjointly in any Group "B" thoroughfare.

The astragals are constructed of very narrow members and the frog sprays so twisted as to present the smallest possible obstruction to the path of light, thereby reducing shadows to the minimum. All glass panes are identical in shape and size, minimising stores and maintenance costs, and are easily clipped into position. Special toughened glass panes are used in all lanterns over and above three-light sizes. They are  $\frac{1}{2}$  in. in thickness, specially manufactured to resist thermal shock and a considerable amount of impact shock. Further, they will withstand a temperature of 200 deg. C. one side, while the other is exposed to



Fig. 3.  
Sugg's Group "B"  
"Southport"  
lantern.

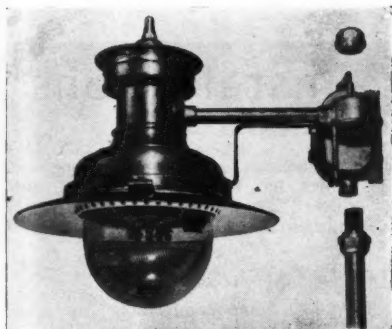


Fig. 4. Showing a new method of mounting for Edgar's 'Eclipse' street lamp.

normal weather conditions. It is twice as strong as ordinary glass of the same thickness.

Intended primarily for the conversion of existing short-post columns—there are many of these about the country—is the "Eclipse" gas lamp with the new mounting. (See Fig. 4.) This is the product of William Edgar and Son, Ltd., London. The circular copper lamp is fitted normally with five No. 2 mantles, together with a Holophane refractor to give a form of light distribution compatible with present requirements. The chief feature of the design lies in the arrangements which have been made to make the lamp and controller unit very readily detachable from the vertical arm, so that in the event of anything other than normal maintenance being required the entire unit can be slipped off, overhauled, and replaced with the minimum of trouble.

Space forbids our giving further examples of modern gas lighting units, but a word should be included regarding the part played by equipment for the satisfactory automatic control of street lighting. Automatic control has been the subject of study in the gas industry for the past fifty years, as however perfect the street lamp itself may be, its value to the public lies in its being in action at the right time.

In recent years the makers of controllers have contributed a great deal to the improvement in the reduction of maintenance costs of gas street lighting by their attention to those details of control design which can assist the fitter in the speedy discharge of his duties in setting and winding controllers.

In particular, long-running controllers are now available which enable the functions of clock winding and lamp cleaning to be

carried out on the one visit. As a further refinement the solar dial which avoids the need for hand re-setting has come into greater prominence. All of this results in gas lighting giving better service to the public at lower cost.

## Dye Sensitizers

Coloured materials of a different kind from those usually attracting the attention of members of the Colour Group provided the topic for the Group's meeting on March 22, when Mr. H. O. Dickinson of Messrs. Ilford's gave a lecture on "Some aspects of the dye sensitizing of photographic emulsions."

The simplest kind of photographic sensitization is remarkable enough: the sensitizer dye which in aqueous solution shows one or two absorption bands in the red is absorbed on the silver halide grains, and as a consequence the latter becomes light-sensitive not only in the normal blue and blue-green region of the spectrum but also in the absorption bands of the dye. The exact manner in which this is brought about is still far from clear. The basic conception is that the molecule of the dye is so closely attached to the silver halide grain that an electron ejected when the dye molecule absorbs a *quantum* of red light passes into the silver halide and occupies the same energy level (or band of levels) as an electron liberated in the silver halide by the direct absorption of a *quantum* of blue light. From this point, the formation of the latent image in the emulsion grains is supposed to proceed normally. Mr. Dickinson explained that the observed sensitization given by many dyes is more intense and extends farther in the red than would be expected from the absorption bands of the aqueous solution of the dye. This is attributed to the formation of a kind of multiple molecule or polymer when the dye is absorbed, the molecules present in the solution as units or pairs (dimers) being stacked like cards in a pack with their edges attached to the silver halide surface. It is theoretically plausible to assume that such structures would develop absorption bands deeper in the red. Among the many interesting points discussed by Mr. Dickinson may be mentioned the "poisoning" of sensitizers, the spectral sensitivity produced by mixed sensitizers, the effect on sensitization of increasing the normally small proportion of silver iodide in the emulsion, and the importance of a correspondence between the lattice spacing of the silver halide and the "span" of the dye molecule.

## New Lighting Installations

### Lighting for Worsted Weaving

The interesting installation of fluorescent lighting fittings in the Trafalgar Mills of Learoyd Bros. and Company, of Huddersfield, shown in the photograph, illustrates the neat arrangement which can be obtained with fittings mounted in continuous rows.

Planned to give maximum lighting over the looms, with the additional benefit of good general illumination, the layout has resulted in an effective and efficient installation. Utilising 450 of the open-top dispersive Ekco-Ensign fittings (type FF13), fitted with 5-ft. 80-watt lamps, a service illumination value of 45 lumens/sq. ft. has been achieved. The fittings are mounted at a height of 8 ft. 6 ins. above floor level and are chain suspended. As this type of fitting permits maximum downward light combined with some light on the ceilings and walls, any suggestion of "tunnel"

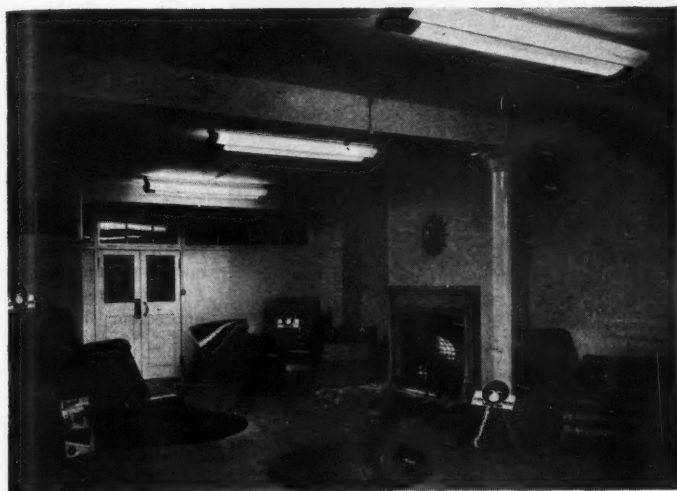
effect, sometimes noticeable with long rows of fittings, has been effectively overcome. Messrs. H. C. Stringer, of Huddersfield, were the installers.

### Showroom Lighting

A small but comfortably appointed showroom for the display of carpets in the premises of Messrs. Edwin Field and Sons, Ltd., Little Britain, London, E.C.1, employs fluorescent lighting with decorative style fittings in order to maintain the desired atmosphere of the "salon." The lighting units are Mazda fluorescent lamp fittings (Cat. No. F1214), these being of a louvered type with "Perspex" side panels, ceiling mounted and housed twin 5-ft. 80-watt "Natural" fluorescent lamps. Lighting intensity of about 20 lumens per square foot is achieved. Switching is arranged so



A fluorescent lighting installation in a worsted weaving mill.



(Left).  
Showing decorative fittings for the lighting of a carpet show-room.

(Below).  
Simple but effective lighting achieved by the use of a continuous line of fittings.

that the section farthest from the outside window may be operated first when required, when the artificial light blends with natural daylight to enable colours to be appreciated and texture and appearance to be assessed at any time.

The firm's offices have been equipped with diffusing fittings, again giving approximately 20 lumens per square foot illumination level. The use of this style of fitting gives an appearance of uniformity with other floors in the same building when viewed from the street, other firms in the premises having had the same type of unit installed.

#### Lighting a Clothing Shop

The new showrooms of Messrs. H. J. Nicoll's, Ltd., of Regent-street, W.1, are essentially of a simple character, and it was important that this should also be a feature of the lighting equipment.

Really good colour rendering was also necessary, whilst 20-ft. candles was the minimum





(Left). Showing the effect of blended light in a rail bending shop.

standard of illumination required. Furthermore, with a predominance of feminine clientele, the appearance and brightness of the fittings were a serious consideration.

The photograph on the previous page shows how these requirements were met: simplicity was achieved by a single continuous line of twin 80-watt lamp units, with good colour rendering by the use of "Atlas" 4,500 deg. K "Daylight" lamps. The illumination values were 40-ft. candles maximum, 20-ft. minimum. Attractive appearance and acceptable brightness ratios were obtained by the use of a fitting totally enclosing the lamps within a ribbed "Perspex" diffusing cover.

The scheme was to the specification of Thorn Electrical Industries, Ltd., who also designed and supplied the lighting equipment.

#### An Application of Blended Light

The Darlington Railway Plant and Foundry Co., Ltd., manufacture switches, crossings, turnouts and general track work for railways all over the world, and when they recently constructed a new erection



(Below). This extensive installation in a textile mill is comprised of 5-ft. 80-watt daylight fluorescent lamps in G.E.C. vapour proof fittings. The average illumination values on the weaving frames is between 25-28 lumens per sq. ft.

shop they called in Metrovick Illuminating Engineers to advise them on the lighting.

It was found that while mercury discharge lighting provided the most economical lighting load, the colour rendering was unsuitable as the floor of the shop is used for marking out in different coloured chalks. The blended lighting finally decided upon has proved entirely satisfactory.

Each reflector incorporates one 400-watt discharge lamp and one 500-watt tungsten lamp. These are mounted 27 ft. above ground level and provide an even illumination of 9/10 lumens per sq. ft.

# Problems in Illuminating Engineering For Students

By S. S. BEGGS. M.A., F.I.E.S.

## 8. Daylight.

Some knowledge of the character of natural "daylight" is obviously necessary, as so often it is quoted as the ideal light, although even the user may not know quite what he means by it. This should have been covered in the Intermediate Grade course, but may well be required again in relation to artificial daylight sources. Methods of providing artificial daylight in common use, with their characteristics, relative advantages and appropriate fields of use should be studied.

An understanding of the measurement and specification of daylight in interiors is important. An introduction to these and to the simpler technical terms will already have been made at the Intermediate stage, but a fuller knowledge—for example, of the Waldram diagram or the Duffon scale—would be expected; the forms of daylight contours typical of different window constructions and the effect on these of obstructions should be considered. Accepted minimum requirements and recommended practice (I.E.S. Code) should be known, although the detailed values in the Code need not be memorised. It should be observed that the recommendations of the Code may be impossible to obtain in some situations in built-up areas.

Important additions to the factors affecting the access of daylight to interiors which require consideration at this stage are the form of the building and its height and location relative to other buildings. An extension of such a study is the access of sunlight (insolation) and its relation to the aspect of rooms and the building form. Although in this climate sunlight is rarely excessive, methods for reducing glare due to too high contrasts in the interior also require consideration. A very useful publication on the daylighting of buildings is the Post-War Building Studies, No. 12, entitled "The Lighting of Buildings," published by H.M. Stationery Office. It deals with the principles of design in relation to daylight, sunlight and artificial light, and their

application to the lighting of dwellings and schools.

### Question 14 (1948)

*Explain the terms "Daylight Factor," "Sky Factor," and "No Sky Line." How may the Sky Factor be calculated and recorded on the plan of a given room?*

### Answer

#### (i) EXPLANATION OF TERMS.

The illumination provided by daylight (either indoors or out of doors) varies over a very wide range, not only with the season of the year or time of day, but even from minute to minute. Therefore the specification of daylight in a room in terms of illumination values has little meaning. However, it has been found in practice that, so long as the external level of illumination is above a certain minimum value, the judgment of the quantity of light in an interior depends not on the illumination value itself but on its ratio to the external illumination. The basis of the recording or specification of interior lighting by daylight therefore differs from that by artificial light in that the actual illumination is not quoted, but its ratio to that which is provided outside by the whole unobstructed hemisphere of sky.

This ratio will vary considerably because the sky brightness distribution varies; for this reason measurements are made only when the conditions are as uniform as practicable, preferably totally overcast sky, and calculations assume absolute uniformity of the sky brightness. Direct sunlight must be regarded as a temporary addition, and is excluded from these values.

In recording the daylighting of existing buildings, simultaneous internal and external illumination measurements are compared; their ratio is the *Daylight Factor* for the specified point in the room. It should be noted that the illumination at the interior point includes light reflected from the walls, etc., as well as that directly incident through the window.

In calculating the natural lighting that will be provided in a room, for example

The first article in this series appeared in Vol. XLII, No. 9, September, 1949.

in a building that is being planned, it is impossible to make exact allowances for such reflections from surroundings. With a uniform sky, however, any sky visible behaves as a diffusing area source, and the illumination at any point in the room due to direct light only can be calculated, in terms of the sky brightness, from the geometry of the situation. The ratio of this direct illumination to that from the complete hemisphere of (uniform) sky is independent of the sky brightness assumed; this ratio is termed the *Sky Factor*. Since only direct light is included, the Sky Factor is zero at points at which no part of the sky is visible.

As the sky is much brighter than the surroundings, at any point in the room from which any of the sky is visible the direct light provides the major contribution to the illumination, and so the Daylight Factor and Sky Factor will not differ greatly; also they decrease rapidly as the area of sky visible through the window decreases. Any point from which no sky is visible will have a very low Daylight Factor and zero Sky Factor, and will almost certainly be inadequately lighted. The line marking points at which the sky just ceases to be visible is termed the *No Sky Line*; it provides a readily determined approximate demarcation of the region of the room which has inadequate natural lighting.

#### (ii) CALCULATION AND RECORDING OF SKY FACTORS.

The Sky Factor may be calculated by any of the standard methods applicable to area sources of uniform brightness, taking the area of sky visible through the window as the source. In practice the outline of this area is usually so irregular, due to external obstructions, as to make impossible the direct application of the simpler formulae for areas of standard geometrical pattern.

The basic relationship is:

$$\delta E = B \sin \theta \delta \omega$$

where  $\delta E$  is the illumination on a horizontal surface received from the element of sky of brightness  $B$ , which subtends a solid angle  $\delta \omega$  at the point in a direction of elevation  $\theta$ . The well-known hemispherical projection method, which is an obvious direct application of this formula, may be applied, but it entails considerable labour and the projection is unfamiliar and awkward to measure. The Waldram diagram, derived from the same formula, is more convenient; it is a rectangular web, in which the abscissa scale of azimuth is

uniform and the ordinate scale of elevation  $\theta$  proportional to  $(1 - \cos 2\theta)$ , so that areas on the web are directly proportional to the illumination ( $E$ ) from the corresponding areas of sky. If the outline of the window and obstructions (as seen from the point under consideration) is plotted and the enclosed area measured, the Sky Factor is the ratio of this area to twice that of the whole diagram (for the usual range of  $\theta$  from 0 to 180 deg.).

One alternative method employs a system of protractors. For another a set of "Graded Daylight Factor Tables" has been prepared, giving the dimensions of the Sky Factor curves for specified window sizes; a series of graphs is available giving similar information. Numerous mathematical solutions have been proposed, and Dufton has devised a scale, based on the formula for a finite line source normal to the plane of measurement, by means of which the Sky Factor can be determined simply from a scale drawing of the window. Most of these methods are approximate, and have only a limited application.

The distribution of Sky Factor in a room is usually recorded on the plan of the room by means of lines joining points at which the value of the factor is the same. These are known as daylight contours. The line of zero Sky Factor will obviously coincide with the No Sky Line, and there will be no contour lines beyond this line. The Daylight Factor and Sky Factor values recorded are usually for the horizontal plane at 2 ft. 9 in. above floor level.

#### Question 15 (1948)

*Discuss the design of city buildings from the point of view of adequacy of daylight.*

#### Answer

In the design of city buildings two main aspects have to be considered. The first is the form and arrangement of the buildings, so as to cause the minimum amount of obstruction of skylight to one another, and the second is the design of the elements of the individual building (e.g. form of window, or architectural features) so as to make best use of the light that it receives.

It is generally not difficult to obtain a high Sky Factor at a point close to a window; the difficulty lies in providing adequate penetration of the daylight towards the back of the room. Since the No Sky Line approximately outlines the region in a room in which the access of daylight is inadequate, and since the lower the elevation of an

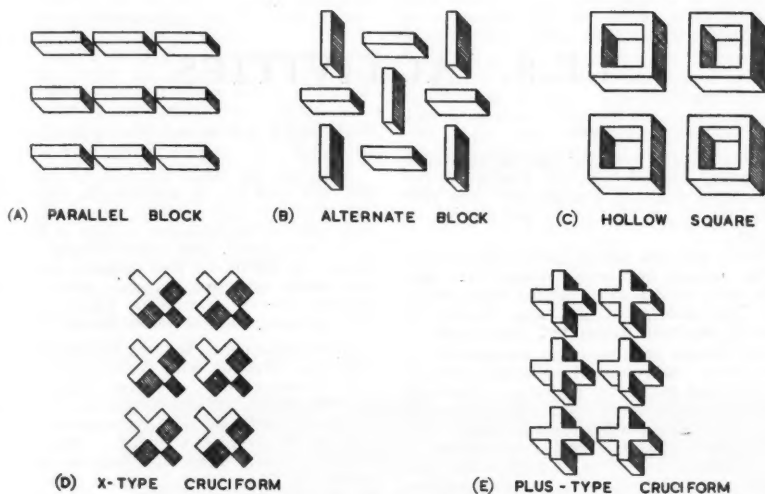


Fig. 6. Showing various arrangements of buildings.

external obstruction the further back will this line lie, it is clear that a broken line of facing buildings is preferable to straight parallel rows; some sky is likely to be visible above the lowest point of the opposite roof line even well back in the room. The usual parallel block formation, shown in Fig. 6 (a), is therefore one of the least efficient from this point of view. If the buildings are arranged alternately with their lengths at right angles, as indicated in Fig. 6 (b), for the same size and density of buildings the penetration is approximately doubled.

The buildings, of course, need not necessarily have a plain vertical frontage, and some small gain may be obtained by setting back the upper stories, so that the elevation of the top of the buildings is decreased.

In large city blocks the "hollow square" form shown in Fig. 6 (c) is often used. Access of daylight to the rooms facing inwards on a deep light well or outwards where the spacing between blocks is narrow is very poor, and the average for all rooms is similar to that for the parallel block layout of Fig. 6 (a). For the same floor space, either of the cruciform arrangements of Figs. 6 (d) or 6 (e) is much preferable, the penetration being again nearly doubled. That of Fig. 6 (e) is slightly better than that of 6 (d). Related forms, such as T or L shapes or a zigzag layout, are also to be recommended.

(The London Transport Headquarters in Broadway—the highest office building in London—is an outstanding example.)

The access of daylight is affected by the relative height and spacing of the buildings, but to a lesser degree than by the building form. To provide the same floor area per acre, if buildings are spaced further apart they will have to be increased in height. For a low density of development (such as a residential suburb) the access of daylight is not materially affected by this change of spacing and height, but in the more densely built-up commercial districts increase in spacing and height of buildings is beneficial, the more so the smaller the spacing—height ratio initially. This applies particularly to the parallel block arrangement general in the business quarter, and refers to a planned layout, not random building.

In considering the effect of features of the building itself on penetration of daylight it has been said that "an inch of window at the top is worth a foot at the bottom," and this is roughly true, especially in densely built-up areas. Thus height of window is much more important than width, and obstruction of the top of the window, for example by a balcony—so popular in blocks of flats—or heavy mouldings, is undesirable. A bow window is bad for the same reason; it increases the daylight close to the window,

(Continued on page 158)

## I.E.S. ACTIVITIES

### London

At the London sessional meeting on March 14 a paper entitled "Acrylic Enclosures for Flameproof Lighting Equipment" was presented by Mr. P. H. Collins and Dr. W. E. Harper.

During the past two or three years considerable interest has been created by large-scale trials of coal-face lighting using 18-in. and 2-ft. fluorescent discharge lamps in specially designed flameproof equipment.

The fittings require large transparent or translucent enclosures of sufficient strength to withstand the severe operating conditions prevailing at the coal face. They must be able to withstand the impact of flying rock during shot-firing, the stresses generated by the accidental explosion of gases within the fitting and also the very rough handling to which they are subjected.

Knowledge of the general properties of the acrylic plastic polymethyl methacrylate suggested that, in spite of certain limitations, it might be suitable for these fittings, and the enclosures of many of the trial units were made from this material. The design of these first enclosures was necessarily based on empirical data, but while the trials have been in progress the behaviour and properties of methacrylate relevant to its use in coal-face lighting equipment has been investigated.

Impact tests have been made, using a modified form of the apparatus described in B.S. 889. The impact strength of a component will depend upon its size, shape and wall thickness, and the relation between impact strength and thickness has been determined for cast methacrylate discs of various diameters. Experiments have shown that the impact fracture strength of methacrylate increases with temperature and also that it is substantially higher when struck by a sharply pointed hammer than when a round-nosed hammer is used.

At present very little information is available on the strength necessary to prevent breakage in service, caused by shot-firing, but such data as has been obtained to date suggests that this strength may be of the order of 100-150 in.-lb. This is much above the impact strengths listed in B.S. 889, but can be satisfied by methacrylate of most sizes if material of  $\frac{1}{4}$ -in. or  $\frac{1}{2}$ -in. thickness is used. Tests have shown that the impact strength of methacrylate of given size and thickness is very consistent and that variations due to

the material can be covered by a factor of about 1.2.

Although the static strength of methacrylate falls with rise of temperature, explosion tests made on shapings have shown that their behaviour at temperatures as high as 85 deg. C. is very good, and there should be no danger of failure of well-designed components under explosive stresses. Precautions should, however, always be taken to avoid local concentration of stress during shaping.

Investigation into shaping techniques suggests that pressing with feed-in of material will produce the strongest components. Heating before shaping must be carefully controlled and a heating temperature of 150-160 deg. C. is recommended. Shaping of methacrylate at either too high or too low temperature can result in serious degradation in mechanical properties and must be avoided.

In common with many other thermoplastics, methacrylate has a limited operating temperature. Experiments have shown that this limiting temperature is about 85 deg. C. for methacrylate shapings which are uniformly heated. Allowance must, however, be made for the temperature gradient through the material which is of the order of 10-15 deg. C. for  $\frac{1}{4}$ -in. thick sheet. When filament lamps are used, this limiting operating temperature can be largely exceeded if the convection currents of hot air rising from the lamp impinge directly on the shaping. This can sometimes be prevented by incorporating a baffle in the fitting to break up the air streams, so preventing local overheating.

Methacrylate has exceptionally good optical properties and is available in different grades of opalescence as well as in clear and coloured forms. The optical characteristics of the material have been determined and some experiments have been made with opal methacrylate covers in an attempt to reduce the glare associated with coal-face lighting. This remains one of the most difficult problems which illuminating engineers must overcome in the development of satisfactory mine lighting.

The rough handling which fittings receive in mines results inevitably in some abrasion of the methacrylate covers. Scratch tests show that the material's resistance to abrasion is about the same as that of aluminium, and attempts to harden the surface have not been successful. Covers can be reconditioned by mechanical polishing, but this may not

be permitted on account of the practical difficulty of determining the effect of reconditioning on mechanical strength.

The results of this investigation coupled with data from the present trials suggests that methacrylate enclosures can be designed having very good optical performance and whose strength is fully adequate to withstand damage by shot-firing and by internal explosion. Damage during dismantling is the most likely cause of failure. By using a sufficient thickness of methacrylate failure from this cause could also be overcome, but a more economical solution would seem to be obtained by the use of metal guards.

#### Birmingham Centre

The fifth sessional meeting, which was also the annual general meeting of the Birmingham Centre, was held at the Imperial

work could cause deterioration of eyesight. He suggested that the I.E.S. could usefully do some educational work in this connection.

Mr. Steel then went on to discuss the problem of glare, both from natural lighting and artificial lighting. The Building Regulations prescribe a daylight factor of not less than 2 per cent. The large window area brings further problems, such as excessive glare on bright days, and expensive curtains and ventilation when artificial light is used. The ideal system would be an automatic one, in which the artificial light used would be a close match to daylight, and the daylight would be automatically controlled by window louvres, and the artificial light automatically switched on or off as needed, the whole being controlled by photocells at a fixed value of illumination. He was also of the opinion that new and more efficient

At the Liverpool Centre annual luncheon. Left to Right: — Sir Vincent Z. de Ferranti, Mr. K.R. Mackley, The Lord Mayor of Liverpool, Alderman J. J. Cleary, J.P. Dr. J. N. Aldington, and Mr. C.C. Smith.



Hotel on March 10, when a paper, entitled "School Lighting, the Architects' Problem," was given by Mr. A. Steel, F.R.I.B.A., architect to the Birmingham Education Authority.

In his introductory remarks Mr. Steel stressed the fact that school design was constantly changing, economic forces being often a deciding factor. Another factor was the general trend of education towards free activity, and also the fact that assembly halls, dining rooms, and circulation space will be put to dual uses. The lecturer went on to discuss the standards of lighting laid down in the Education Act, 1944, Sec. 40, recalling that the Ministry stresses that lighting is the responsibility of the architect.

Speaking of the children's eyesight, the speaker was of the opinion that the short time spent by children in working by artificial light would have little or no detrimental effect, but that there was a possibility that poor lighting in the home during home-

light sources of larger area and lower brightness would be forthcoming. He would like to see the whole of the ceiling area as a light source, but, as the over-riding question was cost, it would have to be reasonably cheap.

In conclusion, Mr. Steel paid tribute to the fine work being done by the I.E.S., and said that he hoped lighting engineers would receive suitable instruction in building practice and design.

During the discussion which followed, pleas were made for storied buildings in towns, a badly needed alternative to the inevitable diffusing fitting, and for the education of the people generally in good lighting.

#### Liverpool Centre

The annual luncheon of the Liverpool Centre was held at the Adelphi Hotel, Liverpool, on Monday, March 27, when the Centre welcomed as their chief guests, the Lord

Mayor of Liverpool, Alderman J. J. Cleary, J.P., president of the society, Dr. J. N. Aldington and Sir Vincent Z. de Ferranti, chairman of the British Electrical Power Convention, and many distinguished members of kindred societies in the area.

In proposing the toast to the City and Port of Liverpool, Dr. Aldington dwelt on the vision of those people some hundreds of years ago, who conceived the idea of Liverpool becoming a great port and eventually the gateway to the Empire. In congratulating its present generation of rulers he mentioned the fact that in many cases the first impressions of England received by foreigners was a visit to this city.

The Lord Mayor of Liverpool made a brilliant reply, and particularly referred to the fact that Liverpool had been selected as one of the centres for the Festival of Britain. He made particular reference to the possibilities of floodlighting and also paid tribute to the part that the Liverpool Centre was playing in the cultural life of the city.

An address was afterwards delivered by Sir Vincent Z. de Ferranti, who recalled that it was just over a hundred years ago, in 1847, that a Frenchman, Foucault, demonstrated the first electric light in London on the Duke of York's statue. He thanked Dr. Aldington for reminding the assembled gathering that Liverpool was the birthplace of his illustrious father, Dr. Ferranti, and went on to give some particulars of his life.

In the early part of his address, Sir Vincent stated that lighting was the first field conquered by electricity, and this gave the urge for the development of the electric system of generation and distribution. After the arc and incandescent lamps, appeared the electric motor and 3-phase current, which was steadily putting more h.p. behind every producer in the country. He said that the electric supply industry is faced with the double task of catching up with the normal increase of the use of electricity of from 7 to 10 per cent. per annum, plus that of replacing all the existing plant. Not before then could we look forward to a cheap and abundant supply of electricity.

At the conclusion, Mr. C. C. Smith, chairman of the centre, thanked the Lord Mayor and Sir Vincent for attending. He also made reference to the growth of the centre and the part that it was playing in the affairs of the Society.

#### Sussex Group

On March 24 the Sussex Group who usually hold their meetings in Brighton met in Eastbourne under the chairmanship of Mr. Norman Boydell, manager of the East Sussex and South West Kent Sub-area of the South Eastern Electricity Board. The

attendance was one of the largest since the formation of the group, some 80 members and visitors being present. The visitors included a number of representatives of the electricity supply industry, architects, contractors and representatives of local authorities for many parts of Sussex.

The lecture at this meeting was given by Mr. W. T. F. Souter who spoke of the engineer's approach to the lighting problem during which he described a wide variety of lighting installations. The discussion which followed the presentation of the lecture was very lively. It was felt that the group's first meeting in Eastbourne was a great success and it is to be hoped that it will be followed by more equally successful meetings in the future.

### SITUATIONS VACANT

**LIGHTING SALES ENGINEER** required for West Country and South Wales by large electrical manufacturers. E.L.M.A. members. Must have an electrical background, preferably Nat. Cert. Lighting experience preferred. Car driver essential. Write, giving full particulars of age, previous experience, and salary required, to Box 806.

**TWO SALES ENGINEERS** for London and Nottingham Areas required by E.L.M.A. manufacturers of lamps and lighting equipment. Electrical training and experience. Nat. Cert. E.E. preferred. Lighting knowledge an advantage. Car provided. Must have urge to sell. Remuneration according to qualifications. Write, giving full particulars of age, experience, and salary required, to Box 807.

### Problems in Illuminating Engineering for Students

(Continued from page 155)

but reduces it at the back of the room. With a low window-head, too, all the light strikes the work rather more obliquely than is generally desirable. Heavy frames and deep reveals are obviously to be avoided as forming obstructions, but if the inner reveal is cut back it helps to reduce the contrast between the window and the wall in which it is set. Inclined and high windows (e.g. north lights or clerestory) may give better uniformity of lighting than side windows, but their application is obviously limited, and the use of them alone is not very satisfactory.

# NATIONAL ILLUMINATION COMMITTEE OF GREAT BRITAIN

(Affiliated to the International Commission on Illumination)

## ANNUAL REPORT FOR THE YEAR 1949\*

Although the work of the Committee is largely of a technical nature, the outstanding event of the year has been a radical change in the manner in which the funds of the Committee are to be raised. So far during the 35 years of the Committee's existence, the money needed to meet the annual subvention to the International Commission on Illumination and certain clerical expenses has all been generously subscribed by the three founder bodies—The Illuminating Engineering Society, The Institution of Gas Engineers, and The Institution of Electrical Engineers—but the decision of the 1948 meeting of the Commission to raise the subscription rate has made it necessary for the Committee to meet an amount of £192, as against the previous figure of £78.

A Finance Sub-committee, consisting of five members, was accordingly appointed, and as a result two alternative schemes were suggested, both having as their aim the idea of inviting all bodies represented on the Committee to make a financial contribution. Members were asked to seek the views of the bodies they represented regarding these suggestions, and on the basis of the replies received the Finance Sub-committee suggested modifications to the Rules for putting into effect a scheme which appeared to be generally acceptable. These, and a number of other changes, were then effected in the manner laid down in the Rules themselves, and the new scheme of subscriptions is about to come into operation.

The scheme is briefly as follows: The three founder bodies are to be known as "Sponsoring Organisations" and all other bodies as "Co-operating Organisations," the latter being sub-divided into "trade organisations" and other bodies. Each organisation will be required by the Rules to make an annual contribution of an amount depending on the group to which it belongs; the amounts to be contributed by members of each group are to be fixed by the Committee of Administration, which will also decide the number of representatives to be nominated by each organisation.

The Committee of Administration will consist of nine members, viz., the Chairman, Treasurer, Secretary, one member nominated by each Sponsoring Organisation, and three members elected by the Committee from among the representatives of the Co-operating Organisations.

The necessary elections and nominations to the Committee of Administration have been made and the Committee has met. It has fixed the subscription rate for the Sponsoring Organisations at £32 per annum as at present, and for all Co-operating Organisations at £10 per annum. All bodies at present represented on the Committee will be invited to continue their support under the new Rules, and in addition invitations will be sent to a number of other bodies not at present associated with the work of the Committee.

Although a general measure of support has been expressed for the scheme as outlined, it is not known for certain how many organisations will be prepared to support it, but it is confidently hoped that the scheme will provide sufficient income to meet the Committee's financial obligations.

At the Annual General Meeting held early in February the following elections were made to cover the period until after the next meeting of the Commission:—

*Chairman:* Dr. J. W. T. WALSH.

*Vice-Chairmen:* Dr. S. ENGLISH and Mr. F. C. SMITH.

*Treasurer:* Mr. E. W. MURRAY.

*Secretary:* Mr. L. H. McDERMOTT.

*Representatives on the Executive Committee of the Commission:* Dr. S. ENGLISH and Mr. F. C. SMITH.

One result of the new financial arrangement has been that the Treasurer, Mr. Murray, has now been obliged to resign on account of the fact that the Ministry of Labour and National Service, of which he is the representative, does not consider it appropriate for a member of its technical staff to act as treasurer in an organisation to which the Ministry makes a financial contribution. Dr. English has been elected to fill the vacancy.

The changes which have taken place in

\* Approved at the Annual Meeting of the Committee held on Tuesday, January 31, 1950.

## Constitution of the National Illumination Committee on December 31st, 1949

### Officers :—

*Chairman* : DR. J. W. T. WALSH.

*Vice-Chairmen* : DR. S. ENGLISH and F. C. SMITH

*Hon. Treasurer* : DR. S. ENGLISH, Holophane House, Elverton Street, S.W.1.

*Hon. Secretary* : L. H. McDERMOTT,  
Ministry of Works, 57, Onslow Gardens,  
London, S.W.7.

*Representatives of Great Britain on the  
Executive Committee of the International  
Commission on Illumination* :

DR. S. ENGLISH and F. C. SMITH.

### Nominated by the Contributing Associations :—

*Illuminating Engineering Society* : DR. J. N. ALDINGTON, G. G. BAINES, J. G. HOLMES,  
L. H. McDERMOTT, J. M. WALDRAM.

*Institution of Electrical Engineers* : R. O. ACKERLEY, PROF. H. COTTON, C. W. M. PHILLIPS,  
H. R. RUFF, H. C. SPENCE.

*Institution of Gas Engineers* : J. B. CARNE, A. G. HIGGINS, W. HODKINSON, P. RICHBELL,  
F. C. SMITH.

### Nominated by the Co-operating Associations :—

*Admiralty* : H. A. L. DAWSON.

*Air Ministry* : J. E. CARPENTER.

*Association of Public Lighting Engineers* :  
N. BOYDELL.

*British Electrical and Allied Manufacturers' Association* : J. M. H. STUBBS.

*British Electrical Development Association* :  
V. W. DALE.

*Department of Scientific and Industrial Research* : (National Physical Laboratory)  
DR. L. A. SAYCE, DR. J. W. T. WALSH;  
(Building Research Station) W. ALLEN.

*Electrical Contractors' Association* : C. J. VENESS.

*Electric Lamp Manufacturers' Association* :  
W. J. JONES, E. B. SAWYER.

*Electric Light Fittings Association* : G. CAMPBELL, W. E. J. DRAKE.

*Gas Council* : A. M. BELL, D. CHANDLER.

*Glass Manufacturers' Federation* : DR. W. M. HAMPTON, G. MARCHAND.

*Industrial Health Research Board* : H. C. WESTON.

*Institution of Municipal Engineers* : C. HARPER.

*Medical Research Council* : PROF. H. HART-  
RIDGE.

*Ministry of Civil Aviation* : R. BROADBENT,  
J. V. VERRAN.

*Ministry of Health* : A. SCOTT.

*Ministry of Labour and National Service* :  
E. W. MURRAY.

*Ministry of Supply* : E. S. CALVERT, Brig.  
E. J. H. MOPPETT, J. L. RUSSELL.

*Ministry of Transport* : DR. H. F. GILLBE.

*Ministry of Works* : W. E. RAWSON-BOTTOM.

*Post Office* : DR. C. G. ROBERTS, W. T. GEMMELL.

*Railway and London Transport Executives* :  
A. CUNNINGTON, E. MORGAN.

*Society of British Gas Industries* : S. F. BAKER, W. R. EDGAR, P. C. SUGG.

*Society of Glass Technology* : DR. S. ENGLISH.

the membership of the Committee itself are as follows: Mr. G. G. Baines has replaced Mr. Burnett as one of the representatives of The Illuminating Engineering Society; Mr. J. E. Carpenter is now the only representative of the Air Ministry, having replaced Air Cdr. D'Aeth, W/Cdr. Drake, and Mr. Heyes; Mr. J. V. Verran has replaced Mr. Petts, of the Ministry of Civil Aviation; Brig. E. J. H. Moppett has replaced Brig. MacLennan, of the Ministry of Supply; Mr. W. E. Rawson-Bottom has replaced Mr. G. Smith, of the Ministry of Works; and the Society of British Gas Industries has now nominated Mr. S. F. Baker as its third representative.

As regards the technical work of the Committee, two new Sub-committees have been formed; these deal with Museum Lighting, under the chairmanship of Dr. H. J. Plenderleith, of the British Museum; and Ultra-violet Light, under the chairmanship of Mr. J. Guild, of the National Physical Laboratory. A meeting of representatives of European countries was held in Paris in June to arrange for a series of tests on automobile headlamps; these tests, in which the Americans also took part, were later carried out in Holland in October; the results are awaited. The Committee was represented at both meetings. The international committee which is to consider the subject of the Colour of Light Signals has been set up; Mr. J. G. Holmes has been appointed chairman, and the British representative is Dr. W. H. Willott.

An interesting development of the Central Bureau of the Commission has been the issue so far of four quarterly publications under the title of "Halath Letters," the name being derived from the initial syllables of the names of the President and the Hon. Secretary of the Commission. These letters, which appear to have met with general approval, have dealt with such matters as a suggested time table of events leading to a meeting of the Commission, the views of member countries on the function, number and length of Congress Papers, news from various countries, etc.; information of interest to the Central Bureau has also been requested in the Letters.

The receipt of Halath Letter No. 1, with its request for information, almost coincided with the decision of the Committee to undertake a critical review of its participation in the 1948 meeting, so that it was obviously appropriate to consider both matters together. Accordingly a Panel was formed, with executive powers. The Panel has met three times, and the bulk of its report, which outlined what should be regarded as the ideal method of participation in a meeting of the Commission, was sent to the Central Bureau, and was reproduced in large part in the next Halath Letter. Later the Panel dealt with the inquiry from the

Central Bureau on the question of Congress Papers.

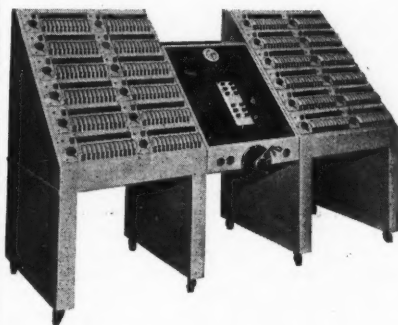
At the request of the Central Bureau, copies of a document giving the names and addresses of the Committee and Sub-committee officers have been sent to member countries, whilst similar documents have been received from France, Holland, Italy, and the U.S.A.

It was with great regret that the news was received in June of the sudden death of Mr. Preston S. Millar, who led the U.S. delegation at the 1939 and 1948 meetings of the Commission.

Printed copies of the Recommendations of the 1948 meetings were received early in the year, but the printed Proceedings, of which 84 copies have been ordered, have not as yet come to hand.

It will be of interest to note the following information dealing with British Standards. Standards issued: B.S.1522: 1949—Schedule of Projector Lamps and B.S.1546; 1949—Lighthouse Lamps (electric); Standards withdrawn: B.S.33: 1930—Carbon Filament Electric Lamps and B.S.307: 1931—Street Lighting; Amendment issued: P.D.888—Amendment No. 5 to B.S.535: 1938—Miners' Lamp Bulbs.

J. W. T. WALSH,  
Chairman.



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## POSTSCRIPT

I wonder whether the doughty, if self-disparaging, "Dimwit" and "Dimmerwit," whose letters have appeared in the two preceding issues of this journal, are arguing on a subject about which most illuminating engineers couldn't care less? Dimwit is happily able to understand a foot-candle so long as he is told that this is what he gets at an easily recognisable foot from an easily recognisable candle. On the other hand, Dimmerwit, whose pseudonym amounts almost to a confession of being "concrete from the neck upwards," is evidently unimpressed by Dimwit's concrete foot-candle. Dimmerwit, I feel, will be tempted to ask Dimwit how his line of argument can be extended to make the foot-lambert easily comprehensible. Can a lambert be easily recognised, and is a foot-lambert that which we get a foot from a lambert? What have students of illuminating engineering to say about all this? Do they find some of our lighting terms queer or clear?

A subject is only understood if we are able to form clear and distinct ideas about it, and Dimwit, who confesses his inability to understand what a lumen is, doubtless takes comfort in the thought that he is not alone in his plight. Illuminating engineering is not too happily named, for it most obviously involves the three "p's"—physics, physiology, and psychology. The "material" with which the illuminating engineer works, namely, luminous flux, is not a physical but a psycho-physical entity. The purely physical "stuff"—radiant energy—by which the eyes are stimulated is not equally effective at all the wavelengths which go to the visible spectrum. Different amounts of radiant energy are required at different wavelengths to produce equal illuminations, so we cannot measure illumination simply in units of its physical agent, but only in units—"lumens"—which take into account the relative spectral visual sensitivity. Of course, this is not an explanation of what a lumen is—for which see the textbooks.

Listening recently to a lecture by Dr. Donald Hunter on the industrial disease known as berylliosis, it was interesting to

### By "Lumeritas"

hear that comparatively few people are susceptible to beryllium poisoning, and that the lecturer was well aware that most British fluorescent tubes do not contain beryllium phosphors. Although careless handling of a broken fluorescent tube is as foolish as careless handling of any other broken glass, if a cut should be sustained there is little chance in this country that the wound will be contaminated by beryllium.

The other day I had the opportunity of measuring the brightness of the Snellen test-charts used in a provincial eye hospital, and was agreeably surprised to find it was more than 120 foot-lamberts. Such a value, though necessary if the approximate upper limit of patients' visual acuity is to be ascertained, is by no means usual practice. Indeed, in a treatise (American) on Industrial Ophthalmology, published as recently as 1944, it is said of the Snellen test that "the lighting should be uniform, the source not visible to the testee, and of 7 foot-candle power." However, as Sir John Parsons recently reminded us in this journal, British ophthalmologists in 1935 recommended that the illumination of Snellen charts should not be less than 10 foot-candles, and this minimum is certainly often exceeded in present practice.

The articles on home lighting in last month's *LIGHT AND LIGHTING* prompt me to draw attention to a daylight deficiency which is characteristic of most of our semi-detached and terrace houses. In these the fireplaces are built into the party-wall, and the windows into walls at right angles to it. Now the family sit round the fire in six months of every year, and whoever sits at the side remote from the window faces the light source, while anything he may wish to read can only be indirectly and comparatively feebly illuminated by light reflected from the wall behind him. A change of plan, so as to locate the fireplace and the windows in opposite walls, might add to the frontage required and to building costs, so suitable daylighting is sacrificed for economy. Central heating, instead of open fires, would overcome this difficulty.

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